DESCRIPTIVE ANATOMY.

MANUAL

OF

DESCRIPTIVE

AND

PATHOLOGICAL ANATOMY,

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BOOK V.

NERVOUS SYSTEM.

§ 1710. The nervous system* is generally divided into that of *animal* life and that of *vegetative* life, or into the *cerebral* system and the *ganglionic* system. Both are composed of an *internal* or *central* part, and of an *external* or *peripheric*. But we have already mentioned the reasons which prevent us from drawing the line between these two systems as distinctly as is usually established. We shall discuss the question more fully when speaking of the great sympathetic nerve. We shall then consider the nervous system as a whole, divided into a centre and a periphery.

SECTION I.

CENTRAL PART OF THE NERVOUS SYSTEM.

§ 1711. The central part of the nervous system is composed of the *spinal marrow* contained in the spinal canal, and of the *encephalon* contained in the skull. Bartels has proposed to designate it by the

* Besides the writers mentioned in the first volume who, in their general remarks on the nervous system, have given a complete description of the central part of this system, and who have even described in part its periphery, as Willis and Vieussens, we shall mention also the following, 1st, for the topography of the whole nervous system, A. Monro, *An. of the human bones, nerves, and lacteal sac and duct*, Edinburgh, 1732, 1750, 1777.—Id., *Nervorum an. contracta lat. reddita a Coopmans*, Franeker, 1754.—R. Martin, *Institutiones neurologicæ sive de nervis corporis humani tractatio*, Stockholm, 1781.—J. G. Haase, *Cerebri nervorumque corporis humani anatome repetita*, Leipsic, 1781.—D. E. Gunther, *Cerebri et nervorum distributionis expositio*, Duisburg, 1786.—G. Coopmans, *Neurologia c. obs. de calculo ex urethra extracto*, Franeker, 1795.—2nd. Topography of the whole central portion or of some of its parts; N. Steno, *Discours sur l'anat. du cerveau*, Paris, 1769.—H. Ridley, *Anatomy of the brain*, London, 1695.—V. Malacarne, *Nuova esposizione della vera struttura del cerveletto umano*, Turin, 1776.—S. T. Sœmmerring, *De basi encephali et originibus nervorum e cranio egredientium*, Gottingen, 1788.—V. Malacarne, *Encefalotomia nuova univer.*, Turin, 1780.—Sœmmerring, *Vom Hirn und Rückenmarck*, Mayence, 1788.—Malacarne, *Neuro-encefalotomia*, Pavia, 1791, 1798.—Sœmmerring, *Tabula baseos encephali*, Francfort, 1799.—Chaussier, *Exposition sommaire de la struct. et des dif. parities de l'encephale*, Paris, 1807.—Sœmmerring, *Academicæ annotationes de cerebri administrationibus anatomicis vasorumque ejus habitu*, in the *Denkschriften der acad. zu München*, 1809.—Rosenthal, *Beytrag zur encephalotomie*, Weimar, 1815.—C. L. Somme, *Recherches sur l'anat. comparée du cerveau*, Antwerp, 1824.—Rolando, *Saggio sulla vera struttura del cervello*, in the *Dizionario periodico di medicina*, Turin, 1822, &c.—Ludwig, *Scriptores neurologici minores selecti*, Leipsic, 1791, 1795.—In describing each part of the nervous system we shall mention the authors who have treated of them specially.

collective term *cerebrum ;* but the term *cerebro spinal axis* is better. It bulges very much in its anterior or cephalic part, while in its posterior, or spinal, it terminates in a rounded, long, and thin cord. In a full-developed man it does not weigh quite four pounds apothecaries' weight.

CHAPTER I.

SPINAL MARROW.

§ 1712. Of the central parts of the nervous system we ought to mention first the *spinal marrow* (*medulla spinalis*, s. *dorsalis corda spinalis*, Gordon, *Cerebrum oblongatum*, Collins,* *Corps et extremité inferiure du prolongement rachidien de l'encephale*, Chaussier), because it is formed first in the animal series and in the fœtus.

§ 1713. Anatomists are not agreed as to the limits of the spinal marrow. Its lower extremity is well marked because the central portion of the nervous system there ceases; but all authors do not agree in respect to its upper extremity. Some confine the term *spinal marrow* to that part of the nervous system within the vertebral column, so that, in their opinion, it terminates at the first cervical vertebra and at the origin of the first cervical nerve. Others, on the contrary, include also under this term the lowest part of the mass within the skull, the medulla oblongata. Some also add the annular protuberance, the cerebral peduncles, the thalami optici, and the corpora striata.

The last two methods seem to us incorrect, because the medulla oblongata differs much from the cord contained in the spinal marrow, not only in its size but also in its structure and situation, the arrangement and the distribution of its nerves; and because in all these respects it resembles the rest of the mass lodged in the skull. As to the second, the only arguments in its favour are, that the spinal marrow continues uninterruptedly with the medulla oblongata, and that the annular protuberance seems to establish the boundary between this and the rest of the mass in the skull. But these two circumstances prove nothing, because the anterior cords of the spinal marrow are also uninterruptedly continuous with the cerebrum across the annular protuberance, and the posterior are also continuous with the cerebellum, on the outside of this protuberance, so that if we did not regard more essential differences there would be no separation between the cerebellum and the spinal marrow, as the asserters of the third opinion mentioned above maintain.

* Rolando, *Ricerche anatomiche sulla struttura del midolla spinale*, Turin, 1824.—Ollivier, *Essai sur l'anatomie et les vices de conformation de la moelle epiniere chez l'homme*, Paris, 1823.—Racchetti, *Della struttura della midolla spinale*, Milan, 1816.

I. EXTERNAL FORM.

§ 1714. Generally considered, the spinal marrow is cylindrical; it is, however, a little broader from one side to another than from before backward, and thus in the first direction it appears slightly flattened. It may be divided into a *cervical* and a *thoracic* part, according to the regions of the vertebral column it occupies; in its extent from one extremity to the other it has several prominences.

The first is seen at the upper part of the neck, where the cord becomes a little broader. Its breadth is seven lines in this place, while above it is a little less than six lines. Its thickness from before backward, far from increasing, often sensibly diminishes, and is not quite half an inch.

The *upper* or *cervical* prominence extends from the lower extremity of the cervical portion to the upper extremity of the thoracic portion, where it suddenly stops. Its length is a little more than three inches, and occupies the space between the second cervical and the first dorsal nerve. It is broadest near the fifth cervical nerve. The middle region of the thoracic portion of the spinal marrow again contracts. It is a little thinner than the cervical portion above the upper prominence.

The spinal marrow forms, near its lower extremity, a second prominence, called the *inferior* or the *lumbar*, which is never as large as the upper, and which extends from the first lumbar to the third sacral nerve. This projection is two inches long and five lines broad. It gradually becomes thinner and terminates in a blunt point. This blunt extremity is generally single, sometimes it is evidently bifurcated, and presents a superficial transverse fissure from whence a tubercle arises.

After leaving this point, which corresponds to the first lumbar vertebra, the nervous substance diminishes; and at the extremity of the vertebral canal, the spinal marrow appears only as a rounded filament, a little larger above than below, not quite one line thick in its whole extent, and is formed by the pia-mater. This filament, which may be divided into several longitudinal fibres, descends between the origins of the nerves of the lower extremities, concealed by them, and extends to the lower extremity of the spinal canal, where it is attached to the dura-mater.

Hence it follows that the nervous substance of the spinal marrow, or the proper spinal marrow, by no means fills the whole vertebral canal, and occupies only about two thirds of it, the cervical and the thoracic portions being to the lower portion of the vertebral column as 2 : 1. The spinal marrow is also smaller than the vertebral canal in its other two dimensions.

Its anterior and posterior faces present a longitudinal groove as far as the medullary substance extends; this corresponds to the median line, and is the *anterior* and the *posterior median groove* (*scissuræ medullæ spinalis medianæ anterior et posterior*), which divides

this part into two symmetrical halves, a right and a left. These two grooves are extremely narrow, and anatomists differ in respect to their existence and proportional depth.

Some, particularly Haller, assert that the posterior is never or seldom found; Chaussier says expressly that the anterior groove is at least deeper and broader than the posterior; others, as Blasius, Petit, Vicq-d'Azyr, Gall, and Carus, say that the posterior is deeper than the anterior, which Vicq-d'Azyr and Carus think is the broader.

Others, Gordon for instance,* mention no difference between the two grooves. Bichat also expresses himself vaguely, for he only says that the two lateral halves are very distinct, particularly anteriorly.

We have always observed an anterior and a posterior groove, the latter generally very narrow, and rarely deeper than the other, although neither penetrates to the centre of the spinal marrow, and to its grey substance. When the posterior seems deeper than the anterior, we have several times found that it was enlarged during dissection, so that, adopting the opinion of several correct anatomists, our predecessors, we believe the anterior groove to be larger in every direction than the posterior. The latter is much more perceptible in the prominences, particularly the lower, than in the rest of the spinal marrow.

Besides the median groove we observe also, on each side, but not exactly between the first two, and a little nearer the posterior than the anterior, a more superficial groove which proceed obliquely inward and forward, and are called the *lateral grooves* (*fissuræ laterales*). These two grooves proceed then to meet each other and the posterior, whence each lateral portion of the spinal marrow is also divided into two other halves, an anterior and a posterior, the former being much the larger. But these grooves are generally only simple depressions, or are at least more superficial than the preceding. We cannot trace them the whole length of the spinal marrow, and they are seen only in the upper region of its thoracic portion. They separate on each side, the most posterior part of the circumference of the spinal cord from the rest of this circumference, not far from the posterior median groove. They not only converge inward and forward, but also downward, in the longitudinal direction of the spinal marrow, until they finally unite at the summit of its thoracic portion.

These lateral grooves are much more distinct in the early periods of life, than at a later period, when they frequently disappear and leave not the least trace.

We must distinguish them from the other two lateral grooves, the *anterior* and the *posterior* (*sulci laterales anterior et posterior*) which exist on each side, the whole length of the spinal marrow, and which are much broader than the preceding. These grooves receive the roots of the spinal nerves; thus they include numerous small depressions, situated after each other, from above downward, and into which the branches of the nerves penetrate.

* *Mem. de Paris*, 1781, p. 599.

The posterior is larger than the anterior.* It seems to be a real fissure, more than a simple groove, since it penetrates internally as a very thin wrinkle, in the same direction as the lateral groove described above, and meets that of the corresponding side. This posterior groove not only receives the posterior roots of the spinal nerves, but also marks the limit between the anterior and the posterior medullary cords, into which each half of the spinal marrow is divided, and which slightly project upon the surface of the spinal cord, which is otherwise rounded.

II. STRUCTURE OF THE SPINAL MARROW.

§ 1715. We have already described (vol. 1) the intimate texture of the spinal marrow; we then have only to state in what manner the grey and the white substances are united, and the arrangement of the large division of those substances.

I. SUBSTANCES OF THE SPINAL MARROW.

§ 1716. The spinal marrow is composed of a grey and of a white substance, the first of which is everywhere surrounded by the second, and forms a nucleus which this latter envelopes on all parts, or at least in most of its circumference.

These two substances differ in form. The grey is composed of a central transverse portion, and of two lateral parts, which send a penniform prolongation forward and backward. Each prolongation is arched concave outward, convex inward, much thicker and blunter before than behind, where, except in the lumbar projection, which is almost as thick at its posterior part as in the anterior, it terminates in a point which is particularly evident in some subjects. It terminates loosely at the circumference of the spinal marrow, although it is not covered by the white substance, while the latter envelops its anterior extremity.

These penniform prolongations very probably, have intimate relations with the origin of the spinal nerves; for the posterior extends exactly in the groove whence the posterior series of their roots arise, and the anterior also goes towards the anterior groove.

The white substance is arranged in an opposite direction from the grey, is convex externally and internally, and the grey nucleus is lodged in it as in a cavity. It is much thicker on its sides than in its other parts. Its right and left portions are not united forward except by a thin layer, which, however, exists through all the spinal marrow, and separates the anterior groove from the grey nucleus. Vicq-d'Azyr† asserts that they are not united at all posteriorly; he thinks that the posterior groove penetrates to the grey nucleus; but they in fact appear to us to be connected by rather a thick medullary

* *Loc. cit.*, p. 177.
† *Loc. cit.*, p. 600.

layer, the existence of which is proved by dissection and by the analogy of the brain.

The proportional quantity of the grey substance is not the same in all parts of the spinal marrow. There is more of it at the lower than at the upper part of the cord. In the full-grown fœtus, the lower part of the spinal marrow is frequently formed entirely of this grey substance, while in the rest of it a very distinct line of demarcation is already drawn between this and the medullary substance. Not unfrequently the grey substance in the adult is brighter, and the white browner than usual, and thus the texture of the medulla oblongata is more uniform than that of the rest of the central mass.

II. ARRANGEMENT OF THE GREAT DIVISIONS OF THE SPINAL MARROW.

§ 1717. The spinal marrow is composed in all parts of two lateral halves, or of two cords, which are fitted to each other, separated by two median grooves in most of their thickness, but united in the centre by the transverse portion of the nucleus (§ 1716), backward and forward by the transverse layers of the white substance (§ 1718).

Each of these two lateral cords is formed of two halves; an anterior, which is much the larger, the form of which is that of a figure of 8 inverted (∞), and a posterior, which is much smaller and prismatic. The latter passes a little beyond the anterior posteriorly; its base looks outward, and its summit inward.

Those two portions are separated by the posterior prolongation of the grey nucleus, and by the posterior lateral groove. The posterior cords are not only thinner and narrower than the anterior; they are also a little shorter, but not by any means in the same proportion. The lower extremity of the spinal marrow is formed entirely by the anterior, so that, seen from the side, it appears much lower in this place than in the rest of its extent.

Farther, each posterior cord is likewise composed of two portions, an external, which is larger, and an internal, smaller, which are separated by a superficial but very distinct groove. Although this arrangement is also observed in the adult, it is much more evident in the early periods of life, and in animals, during their whole existence.

Most anatomists admit that the spinal marrow is composed of two lateral halves. Asch,* Monro,† and Sœmmerring,‡ have described the two cords which form it more or less minutely, the anterior which is larger, and the posterior which is smaller. Chaussier§ even admits three on each side: he places the anterior and the posterior

* *De prima pare nervorum*; in Ludwig, vol. i. p. 238.
† *Ueber das Nervensystem*, p. 22.
‡ *Nervenlehre*, p. 59.
§ *Loc. cit.*, p. 148.

between the two median grooves and the anterior and posterior lateral grooves, and the middle cord between the latter.*

§ 1718. The large lateral cords of the spinal marrow are fitted to each other in all their length, separated by the median grooves, but again united and blended in the centre. This central part may be termed the *anterior and posterior medullary commissures,* and the *median or cortical commissure.*

Gall thinks that the anterior and posterior medullary commissures differ, the first being composed only on the two sides of longitudinal fasciculi, placed side by side, while the second presents on both sides transverse slips, which exactly fit into each other. As yet we have not been able to satisfy ourselves of these two arrangements.

The posterior cords remain on the same side in all their extent. The anterior, on the contrary, *intercross* at the upper extremity of the spinal marrow, and those of the right side pass to the left, and those of the left side to the right, and all cross obliquely in this place. This decussation, which is about five lines long, is indicated on the posterior face, where the anterior fissure does not exist in all its extent, and gives place to a broad but very superficial depression, to re-appear immediately, and even deeper than before, on the medulla oblongata. It becomes still more apparent on its anterior face, when we carefully separate the spinal marrow transversely in this place. The two cords do not intercross, but pass in a mass from one side to the other; they divide into from three to five fasciculi, which pass some above the others, like the fingers when the hands are clasped. The anterior cords, however, do not wholly cross; their anterior and their posterior parts only present this arrangement. We may easily be convinced of this by a transverse section of the spinal marrow in this place; it is then very manifest, that a white medullary band is detached on each side, from the posterior extremity of the anterior cord, which goes forward and inward, and intercrosses with that of the side opposite, while the lateral parts continue their progress from below upward, uninterruptedly. By this decussation, the anterior part of the grey nucleus of the spinal marrow is divided into two lateral portions, each comprised between the internal face of the decussation, and the external lateral portion of the anterior medullary cord.

But we have never found that the anterior internal part of the anterior cords of the spinal marrow which produce the pyramidal bodies of the medulla oblongata, remains on the same side, and that the intercrossing was confined to the fasciculi which proceed from the

* Gall (*loc. cit.*, p. 115) and Chaussier (*loc. cit.*, p. 148) assert that Highmore mentions each half of the spinal marrow as composed of four cords, and consequently that the whole number of these last is eight. It would seem that Gall repeated the assertion after Chaussier, but we find nothing to justify it in the passage referred to by the Paris professor, (*Anat.* b. iii. p. 1. chap. viii.) and Linden, also quoted by Chaussier, says nothing like it. Although Chausssier rejects Highmore's opinion, it is not, however, contemptible, since by uniting Chaussier's description and our own, we arrive at the same conclusion.

posterior part of this cord to the medulla oblongata.* If it was thus the decussation would not be visible externally; the anterior part would continue uninterruptedly to proceed externally along the same side of the body, and would receive the fibres from the posterior part of the cord on the other side only very deeply, but this is never seen.

This decussation is so evident, that we can hardly conceive of its being doubted by several anatomists, as Sabatier,† Vicq-d'Azyr,‡ Chaussier,§ and Gordon.|| Gordon states that he does not speak of the two or three bands by which the anterior groove of the spinal marrow is interrupted at the union of the cervical with the cranial portion, except on account of the absurd theories with which physiologists have often connected it. But this decussation has been demonstrated since the time of Mistichelli,¶ by Petit,** who was the first to demonstrate it exactly; by Santorini,†† by Vicq-d'Azyr,‡‡ with less of precision and clearness,§§ finally, it has been well described by Gall and Cuvier. It has been partly figured by Petit, Santorini, and Gall.

All the objections against its existence are refuted by a positive fact, that the particulars previously described in the whole spinal marrow, are observed only in the place mentioned, and are there constant.

But the cords of the spinal marrow intercross in no other place, and although the contrary has sometimes been maintained,§§ all other arrangements of the spinal cord which resemble these decussations, are only intended to unite the commissures.

The structure indicated by dissection, is demonstrated by the difference between the phenomena which occur when the central portion of the nervous system is injured either above or below the place we have mentioned.

§ 1719. The substance of the spinal marrow of man is solid, not only when it is perfectly developed, but even some time after birth, although several writers have admitted a cavity within it. We may conclude this from the difference in the opinions of authors in regard to the situation and the size of this cavity. Stephanus mentions its existence only as a general fact, without telling where it is situated.|||| Morgagni asserts that it is placed in the centre of the spinal marrow, especially its upper part, where he has frequently found small longitudinal cavities, entirely covered with grey substance, and where once even he found

* Rosenthal, *Beitrage zur Encephalotomie.*
† *Mém. sur la moelle de l'epine et ces envcloppes*; in the *Trait d'anat*, vol. iii. p. 452.
‡ *Mém. de Paris*, 1781, p. 598.
§ *Loc. cit.*, p. 143.
|| *Human Anatomy*, vol. i. p. 177.
¶ *Dell' apoplessia*, Rome, 1709.
** *Lettre d'un medecin*, 1710, p. 11.
†† *Septemdecim tabul.*, p. 28, 29, vol. ii.
‡‡ *Loc. cit.* p. 598.
§§ We instance Bartel's opinion who considers respiration as a motion dependent on the brain.
|||| *De diss. part. corp. hum.* b. iii. Paris, 1545, b. iii. c. xxxv, p. 341.

one which was very large, five fingers long.* Portal seems to have observed it in the same place: but once he found it comprised all the spinal marrow, and that it appeared to be covered with a very thin membrane: and another time it extended only to the fourth cervical vertebra. Gall, however, describes two canals existing all the length of the medulla, one on the right, the other on the left, which do not communicate with each other, or with the cerebral ventricles, but terminating in culs-de-sac, in the thalami optici, where they enlarge and produce a cavity the size of an almond, while the single and median cavity of the other writers is considered by them only as a prolongation of the fourth ventricle.

We have never found in man after birth, a median canal or two lateral canals. The circumstances under which they have been found by Gall and Portal, prove them to have been morbid. From Gall's observations, it cannot be doubted that the canals he saw were produced by art, since he remarks that they could be demonstrated only by dividing the spinal marrow in such a manner that air might be introduced for six or eight lines. The smoothness and distinctness of the surfaces do not prove the real existence of the canals in question, for the first circumstance depends on the softness of the nervous substance, and the second on the central prolongation of the pia-mater. We shall add one observation which we have always made, viz. that the ease with which these canals may be demonstrated, is in a direct ratio with the softness of the medulla oblongata; and it is much more easy by continuing the inflation to make these communicate with the fourth ventricle, than to follow them into the thalami optici. We have succeeded, when the spinal marrow was soft, in pushing air into its whole length, without employing any cutting instrument, and without thinking that the existence of a normal cavity was proved by the space found in a soft and viscous mass, after having employed such a mode.

We discover only at the top of the spinal marrow, a rounded and extremely narrow canal, from six to nine lines long, terminating below by a cul-de-sac, and continuous above with the floor of the fourth ventricle.

III. WEIGHT OF THE SPINAL MARROW.

§ 1720. The absolute weight of the spinal marrow, in the adult when deprived of its envelops, and entirely separated from its nerves, is more than an ounce. It is to the brain as 1 : 40.†

* *Adv. anat.*, vi. *anim.* 14.

† Chaussier establishes a ratio more favourable to the spinal marrow, as he gives the proportion as 1 : 19—25, but this is evidently wrong, doubtless because the origins of the nerves were not removed.

IV. CONSISTENCE OF THE SPINAL MARROW.

§ 1721. It is generally thought that the spinal marrow is softer than the cerebrum. When, however, it is observed in the recent state, we remark, that although it is less consistent than some parts of the encephalon, particularly the annular protuberance, it is at least harder than the cerebrum and cerebellum.*

CHAPTER II.

ENCEPHALON.

§ 1722. The *encephalon* (*encephalum*), or that part of the central portion of the nervous system contained in the skull, has a rounded and oblong form. It is composed of two parts, which differ in size and arrangement; an inferior which forms its base, and a superior which extends upwards and on the sides. These two parts are however directly continuous with each other, and with the spinal marrow.

The upper part very naturally divides into two portions, the *cerebrum* and the *cerebellum*, which differ in respect to situation size and structure. But it is more difficult to establish divisions in the lower part, since the different segments which form it, pass into each other by less evident shades. Hence, also, the difference which exists between authors in regard to the extent of the parts embraced by the same name.

Thus the term *medulla oblongata* has been used to designate a greater or less segment of the lower part of the encephalon: but some give this name to all the parts which form the lower region of this viscus, while others apply it only to some of them, and are not agreed in respect to the number of the parts which are thus collectively designated.

Many have limited the meaning of the word still more, and employ it only to designate the lower part of the nervous substance, which extends from the occipital foramen to the annular protuberance. Such is, for instance, the method of Haller, Sœmmerring, Cuvier, Chaussier and Bichat. Some of these anatomists, however, particularly Sœmmerring, Bichat, and Chaussier, have considered the medulla oblongata not as a particular portion of the central mass of the nervous system, but only as the upper extremity of the spinal marrow, as we have already remarked.

The middle region of the encephalon is situated in front of this part, and is considered by some writers, as Chaussier and Bichat, as a special segment of this mass, called the *cerebral protuberance* (*protuberantia cerebralis*) by Bichat, and the *mesocephalum* by Chaussier.

But these two authors do not give it the same limits, for Chaussier

* Chaussier, p. 116.—Gordon, p. 182.

states it to be composed only of the annular protuberance, the tubercula quadrigemina, and of the valvula cerebralis, while Bichat includes in it also under the term *prolongations*, those medullary fasciculi which extend from the annular protuberance forward to the cerebrum, and backward to the cerebellum. Others, as Gordon, consider the annular protuberance as belonging to the cerebellum.* Vicq-d'Azyr had already said with more justice, that it must be described separately, and that it belongs neither to the cerebrum nor to the cerebellum.

ARTICLE FIRST.

MEDULLA OBLONGATA.

§ 1723. The best mode, in our opinion, is to include under the term *medulla oblongata*, not only what Haller and his successors have so termed, but also the annular protuberance; to insulate this part from the rest of the encephalon, and then to divide the remainder into two other portions, the cerebrum and the cerebellum. We also maintain this position, as the portion we include under this term still belongs in common to the cerebrum and the cerebellum, while that which is found in front of it, belongs only to the cerebrum, and that which is behind it makes a part of the cerebellum. We also ground ourselves on the fact, that what Haller and others term the *medulla oblongata*, differs so much from the rest of the spinal marrow in respect to structure, that we must consider it separately (§ 1713).

The *medulla oblongata*, in our opinion, occupies all the length of the base of the skull, from the large occipital foramen, to the posterior edge of the sella-turcica. Its form is irregularly quadrilateral as it gradually enlarges from behind forward. It is continuous below with the upper extremity of the spinal marrow, anteriorly with the cerebrum, laterally and superiorly with the cerebellum. We must therefore consider it the point of union, or the focus of these three segments of the central portion of the nervous system.

The posterior and inferior part, the proper medulla oblongata of several writers, may perhaps be termed the *rachidian bulb*, as Chaussier† and Bartels‡ call it; the anterior and upper will retain its usual name of *annular protuberance*.

I. RACHIDIAN BULB.

§ 1721. The *rachidian bulb* (*bulbus rachidicus, bulbus rachidicus superior*, s. *medulla oblongata*, Haller, *pars cephalica*, s. *extremum cephalicum*, s. *spinalis medullæ principium*) is the most posterior and

* *Loc. cit.*, p. 112.
† *Loc. cit.*, p. 120.
‡ *Vom. Athmen*, p. 108.

the most inferior part of the encephalon, the direct continuation of the spinal marrow. It extends from the first cervical vertebra to the centre of the body of the basilar bone, and exactly fills the posterior part of the upper and concave face of this body.

It has the form of an elongated triangle, and swells insensibly from behind forward, and from below upward. It generally does not exceed an inch in length, and its greatest breadth is about eight lines.

I. EXTERNAL FORM.

A. LOWER FACE.

§ 1725. The lower face of the rachidian bulb is slightly convex, and divided by a groove two or three lines deep, into two halves, a right and a left, which is continuous with the anterior groove of the medulla oblongata, from which, however, it is slightly separated by the decussation of the anterior cords (§ 1718).

This inferior face presents two pairs of eminences, the *pyramids* and the *olivary bodies.*

a. Of the pyramids.

§ 1726. The *pyramids* (*eminentiæ*, s. *corpora pyramidalia*, s. *corpora pyramidalia antica*, s. *eminentiæ oblongæ*, Gordon, *medianæ internæ*) are visible with the intercrossing of the anterior cords of the spinal marrow (§ 1718), and are situated entirely inward, so that their internal faces touch. They occupy the whole length of the medulla oblongata. They are from about two and a half to three lines broad. They gradually become broader from below upward, and at the same time their upper projects more than their lower part. They terminate anteriorly by a contracted and rounded extremity, at the posterior edge of the annular protuberance, which projects downward and forward much beyond it. At the same time, they separate slightly from each other, so as to leave in the median line, between them and the posterior edge of the protuberance, a small triangular hollow, into which the pia-mater penetrates. The anterior groove of the spinal marrow extends between the two pyramids, and becomes deeper at their upper part. Although these eminences terminate as such at the annular protuberance, they however pass uninterruptedly through it, and go forward.

There is no decussation above the point we have already mentioned (§ 1718). The pyramids are also separated from each other by the anterior groove, in the rest of their length, always excepting the place directly below their upper extremity, where they are reunited by a small transverse medullary commissure, about a line and a half high. This reunion occurs at least frequently, just before they separate from each other, as if in this place their substance was pressed forward.

Prochaska asserts* that there is no grey substance within them: we have succeeded no better than Vicq-d'Azyr† in finding it.

In passing from below upward, they send off filaments which are entwined round the olivary bodies.‡

b. Olivary bodies.

§ 1727. The *olivary bodies*, the *olivary eminences*, the *lateral eminences*, (*olivæ*, s. *eminentiæ olivares*, Vieussens, s. *laterales*, Chaussier, s. *ovales*, Sœmmerring, Gordon), are situated on the outside of the pyramids. They go a little obliquely from below upward, and from behind forward, and form a rounded very elongated prominence, the largest diameter of which is from above downward. The prominence which disappears gradually above and below, passes from the lower face to the lateral face of the medulla oblongata, and is about seven lines long, two and a half broad, and one high. The olivary eminences do not extend so high as the pyramids: they cease about a line below the posterior edge of the annular protuberance.

The roots of the hypoglossal nerve arise from the groove between them and the pyramids.

These eminences are medullary externally, but the thin layer of white substance which covers them is easily raised, and we then perceive a solid grey elongated nucleus, surrounded by an uneven, and serrated edge, the centre of which is white, and the circumference of a deep grey. This nucleus is always loosely imbedded in medullary substance, and is called the *corpus fimbriatum* (*corpus olivæ fimbriatum*, s. *denticulatum*, s. *rhomboideum*). When cut longitudinally, tranversely, or horizontally, we see very evidently that the grey border of the olivary bodies is interrupted inward, and consequently that the white substance which they enclose, is continuous on this side with the pyramids. This grey edge, on the contrary, unites below with the grey substance of the spinal marrow. From the place of decussation, and even by this decussation, the grey nucleus of the spinal marrow is divided anteriorly into two halves (§. 1718). The olivary bodies seem to be only a development of this arrangement. In fact, new medullary substance develops itself in the grey substance as the spinal marrow enlarges in this place, and is continuous internally with the pyramids. It perhaps would be more correct to say that the latter enlarges outwardly, and that it penetrates into the grey substance in the same manner as the two halves of the spinal marrow separate from each other on the two sides, before it enters the skull, and are enveloped by the grey substance.

* *De struct. nerv.*, Vienna, 1779.—*Opp. min.* vol. I. p. 373.
† *Mem. de Paris*, 1781, p. 587.
‡ Santorini, *Septemb. tab.*, p. 26, 27.

B. LATERAL FACES.

§ 1728. The two lateral faces of the medulla oblongata, are sloped and slightly convex outward. They are formed by a medullary projection situated outward and backward before the olivary bodies, which goes from below upward, and from within outward, and arrives at the cerebellum. This projection is called the *lateral pyramid*, the *restiform body*, the *crus of the cerebellum*, the *posterior eminence*, the *peduncle of the spinal marrow* (*eminentia pyramidalis lateralis*, Tarin; *corpus*, s. *processus restiformis*, Ridley; *crus cerebelli ad medullam oblongatam*, *eminentia posterior*, Chaussier; *pedunculus medullæ spinalis*, Gordon). Those of the two sides unite at their inferior internal extremity. Each of them is a prolongation of the posterior cord of the spinal marrow at its side. Where they unite, they project slightly inward. They separate from each other from below upward, from behind forward, and from within outward.

A thin medullary layer about three lines long, and less than three broad, leaves the back part of the upper edge of the restiform body on each side; this goes inward. These two layers, are separated by the pia-mater, which passes from the restiform body of one side, to that of the other, but they never unite in a state of perfect development. They may be termed the *small bridges of the rhomboidal sinus* (§ 1729), and may be considered as indicating the union of the two posterior cords. A second and larger, and particularly thicker medullary prolongation, arises from the anterior part of the restiform body, and is covered by the root of the pneumo-gastric and hyo-glossal nerves, and is attached to the choroid plexus of the fourth ventricle.

C. UPPER FACE OR CALAMUS SCRIPTORIUS.

§ 1729. The lateral face is imperceptibly continuous with the upper face, by means of the restiform body. This upper face is very much grooved at its anterior and larger part, and these present a triangular depression, which terminates in a point, and is called the *rhomboidal sinus*, the *sinus of the medulla oblongata*, the *ventricle of Arantius*, the *fossa of the fourth ventricle*, the *triangular fossa*, the *calamus scriptorious*, (*sinus rhomboideus*, *sinus bulbi rachidici*, *ventriculus Arantii*, *foveola ventriculi quarti*, Chaussier; *fossa triangularis*, Gordon). This depression extends more or less into the upper extremity of the spinal marrow, where it gradually contracts to a considerable degree.

On the superior face of the medulla oblongata, directly at the side of the median depression, we observe two medullary cords, which gradually enlarge from behind forward, and are only the upper face of the anterior cords of the spinal marrow, which traverse the spinal marrow from below upward. Between them and restiform bodies is a broader layer of grey substance.

a. Medullary striæ of the upper face.

§ 1730. Near the anterior extremity of the upper face, we constantly observe white striæ,* which go from within outward, usually project a little, and generally extend from the median depression to the outer part of the face, but which vary in respect to their existence, number, volume, progress, and direction.

1st. *Existence.* They are, in fact, very constant: but they are sometimes deficient on one, or even on both sides. We have never seen a case of the latter, but the former we have met with twice, and always on the left side. Prochaska† and Wenzel‡ have seen both.

2nd. *Volume.* They vary in respect to the three dimensions. Sometimes they are extremely narrow from above downward, almost capillary, and at the same time single. In other cases they form considerable striæ, which are more than two lines broad. Sometimes, also, they are very thin, and do not pass beyond the inferior face of the rhomboidal sinus, and do not penetrate into it. They not unfrequently form a rounded projection above this same face, and penetrate more or less into the medulla oblongata, so as to arrive at its lower face. Finally their length varies much. Generally, but not always, some or all of them extend outward to the auditory nerve, and usually go inward to the median groove: but sometimes also they proceed beyond this groove, and blend with those of the opposite side. Not unfrequently they do not extend to it. We have generally remarked, that when they are large and numerous, they usually unite in part or entirely, on the median line.

3rd. *Number.* Their number varies sometimes; it is independently of their size, and most generally is inversely as the latter, from one only to fourteen.

4th. *Arrangement.* The striæ of one side generally interlace differently together.§ They are however sometimes entirely distinct.

5th. *Direction.* Their direction, most generally, is more or less transverse, although a little oblique from behind forward. Sometimes they proceed almost directly forward. All, or at least some of these striæ, most generally extend to the auditory nerve, as we have already stated, and very evidently form the most internal part of its origin.

Very commonly also, the anterior which compose the smallest part of the mass, go obliquely farther forward and outward towards the trifacial nerve, although we cannot clearly demonstrate any connection between them and this nerve. The posterior are sometimes attached to the filaments of the root of the pneumogastric nerve.

They frequently vary in a most striking manner, in every respect, on both sides of the body in the same subject.

* Prochaska *De struct. nerv.*, Vienna, 1779.—Wenzel, *De penit. struct. cerebri*, ch. xviii.

† *Loc. cit.*, p. 388.

‡ *Loc. cit.*, p. 171.

§ Wenzel, *loc. cit.*, p. 173.—We have seen this several times.

These striæ are very probably not only the roots of the auditory nerve, but are connected, although less evidently, both with the trifacial and with the pneumogastric nerve, of which we shall speak more fully, when endeavouring to establish a fewer number of cerebral nerves than is generally admitted.

b. Grey bands of the upper face.

§ 1731. Before the white striæ, we see on the upper face of the medulla oblongata, other larger and slightly elevated striæ,* which arise at some distance outside of the median line, so that their internal extremities are never blended. These striæ extend from within outward, gradually swell, are convex forward, and pass over the anterior part of the posterior pyramids. They always unite with the auditory nerve at their external extremity, and are very constant: for of ninety-seven cases they were deficient in only two.† They are called the *grey bands* (*fasciolæ cinereæ*). They are also generally much marked, and are similar on both sides: but sometimes, although very rarely, those of the two sides are dissimilar, or they are scarcely perceptible on either: this peculiarity depends neither on the age nor on the sex. They arise generally by one, and rarely by two roots, and are always single on each side. Their intimate connection with the auditory nerve, is proved by the fact that it disappears in deaf people.

II. TEXTURE.

§ 1732. The cords of the spinal marrow enlarge in the medulla oblongata, and divide there into fasciculi, more evidently than in the spinal marrow. At the same time, the posterior separate from below upward, and distinct bodies, the *olivary bodies*, are developed in the substance of the anterior, which are unconnected with the organization of the spinal marrow.

The anterior cords of the spinal marrow, divide evidently, into at least two halves, an anterior which is smaller, and a posterior which is larger. Of these two halves, the anterior cross and form the pyramids (§ 1726), the posterior ascend behind the olivary bodies, enlarge and form the floor of the *calamus scriptorius*, and of the fourth ventricle. We also find another smaller fasciculus, which Gall asserts is not constant, which Rosenthal has described more exactly,‡ and which our dissections have shown to be constant. This middle fasciculus, which touches the olivary bodies, surrounds them and passes through the annular protuberance to go forward into the tubercula quadrigemina.

* The merit of having made profound researches on these striæ belongs to Wenzel, but he neither discovered their existence nor constancy, nor their connection with the auditory nerve, since all these facts are already mentioned positively by Prochaska. (*loc. cit.* p. 367—391).

† Wenzel, loc. cit. p. 164.

‡ *Beytræge*, p. 24—27.

The division of the posterior cords of the spinal marrow into two fasciculi (§ 1717) is still more evident in the restiform bodies, on account of their enlargement. The internal, which are smaller, swell at the lower extremity of the calamus scriptorius, but disappear in a point before the restiform bodies have terminated their course towards the cerebellum.

II. ANNULAR PROTUBERANCE.

I. EXTERNAL FORM.

§ 1733. The *annular protuberance*, called also *the bridge of Varolius* (*nodus cerebri, pons Varolii, eminentia,* s. *protuberantia annularis, protuberantia encephalica, commissura cerebri*), is a considerable and somewhat regularly quadrilateral eminence, extending however rather more from right to left than from before backward; it is observed on the lower face of the cerebrum, projects more than three lines above the lower face of the medulla oblongata and the cerebral peduncles, gradually becomes thicker on each side near its centre, and is separated from the medulla oblongata and the cerebral peduncles, by very distinct limits. Its greatest length is one inch, its greatest breadth is one inch and some lines, and its greatest height, at its anterior extremity, is nearly one inch. Its anterior and posterior edges are convex on the sides, and concave in the centre, the anterior more so than the posterior. A superficial, but very evident groove, extends all along its inferior face from before backward; this is continuous with the serrated portion of the anterior and of the posterior edge. On the sides, the annular protuberance imperfectly divides internally into two halves, one of which is turned toward the tubercula quadrigemina the other up towards the cerebellum, and both turn around the posterior crura of the cerebellum.

II. TEXTURE.

§ 1734. The annular protuberance is formed externally of white fibres, transverse and convex forward, of which the central and the anterior particularly incline very much backward, towards the cerebellum. It is very firm, and the firmest part of the centre of the nervous system. On examining it internally, which must be done by horizontal, transverse, longitudinal, and even by perpendicular incisions, a little oblique from within outward, and from behind forward, we rewark that its texture is very complex.

Immediately below the external medullary layer, we discover a greyish substance. This substance is not pure: it alternates the whole length of the protuberance with transverse and very numerous bands of medullary substance, which are thin and convex inward, and are attached to the external.

About two lines above the lower face of the protuberance, we observe on each side, almost in the centre of each lateral half, insulated longitudinal medullary fibres, which are directed from within outward, and from behind forward, and alternate with the transverse fibres. They are convex below, and concave above. They form a fasciculus, about four lines high, which contains in its centre only white substance, through which the cortical substance passes upward and downward.

This fasciculus is the direct continuation of the pyramids. It continues uninterruptedly forward with the lower face of the cerebral peduncles.

Next comes always from below upward, a very thick layer of grey substance, interrupted by perpendicular layers of medullary substance, situated some behind the others; then, on this layer is another which is thinner, of longitudinal medullary striæ, convex above, concave below, which arise behind the upper fasciculus of the anterior medullary cords of the medulla oblongata, pass above the central grey layer, blend forward with the lower and thickest layer of medullary substance, and thus arrive upon the upper face of the cerebral peduncles.

Consequently the upper and lower fasciculi which result from the division of the anterior cords of the medulla oblongata, again unite at their anterior part, in the annular protuberance.

The number of the longitudinal striæ, especially the inferior, diminishes much from without inward. They are separated from each other, upward and downward, by grey substance, and disappear entirely at about the centre of the annular protuberance.

The central part is formed of grey and of white substance; it is much higher in this place, and only some longitudinal medullary striæ pass above it.

Thus the anterior medullary cords not only increase in size and divide in their course across the annular protuberance, but they are still directed from within outward.

III. WEIGHT OF THE MEDULLA OBLONGATA.

§ 1735. The entire medulla oblongata generally weighs a little more than half an ounce. Its weight then is to that of the spinal marrow, as 1 : 2; to that of the cerebellum as 1 : 10; to that of the cerebrum as 1 : 74: finally to that of the whole central mass as 1 : 86.

The rachidian bulb weighs three drachms; the annular protuberance one.

ARTICLE SECOND.

CEREBELLUM.

I. EXTERNAL FORM.

§ 1736. The *cerebullum* (*cerebellum*, s. *parencephalis*) * is situated below the posterior part of the posterior lobe of the cerebrum, from which it is separated by the tentorium, and occupies the inferior fossæ of the squamous portion of the occipital bone. We may divide it into the *body* and *crura*, and the body comprises the *lateral* parts and a *centre*.

§ 1737. The *body* of the cerebellum has a rounded and oblong form. Its greatest breadth, which is from side to side, is about four inches. It is about two and a half inches from before backward in its broadest portion: it is two and a half inches from above downward in its centre, and only half an inch at its edges; in approaching which, it gradually becomes thinner, so that it seems a little flattened in the latter direction. Considered generally, it is circumscribed by two slightly convex faces, an upper and a lower, and by four obtuse edges, distinguished into anterior, lateral, and posterior. The upper face is sloped like a roof, that is, it projects most at its central part, whence it descends almost flat to the edges, backward, outward, and forward, although a little less in the latter direction. The inferior face, on the contrary, is concave from before backward, at its centre, so that the anterior and the posterior parts of this groove form the greatest hollow.

The two faces are separated by a groove an inch deep in most of its extent, which corresponds to the posterior edge, and thence goes inward. This is called the *large* or the *horizontal groove of the cerebellum* (*sulcus cerebralis magnus*, Vicq-d'Azyr; *sulcus magnus horizontalis*, Reil). This groove divides the cerebellum into an upper and a lower half, besides the two lateral halves into which it is divided by the median longitudinal groove.

The anterior edge is the shortest, and is rendered very concave by a broad depression. The two lateral edges are straight, longer than anterior, and oblique from before backward, and from within outward. They are continuous with the posterior, where the cerebellum is broader between their posterior extremities. The posterior edge is the longest, and is composed of two very convex lateral halves, which are separated by a median groove, about four lines deep and three broad. This groove is continuous with the median depression of the lower face. Thus the cerebellum is narrower in the centre than in the rest of its extent, and is divided by the anterior and posterior depressions of the edges, and by that of the lower face into two halves, called very

* Rolando, *Osservazioni sul cervelletto*, in the *Memoria della reale academia della scienza di Torino*, vol. xxix. p. 163.

improperly, the *hemispheres*, (*hemisphæræ cerebelli*). Each of these hemispheres has an irregularly quadrilateral form. The outer face of the cerebellum is not smooth. We observe in it numerous slight elevations, formed by the upper face of the layers (*laminæ*). These elevations are convex externally, concave internally, and go unevenly from before backward, being separated by grooves, into which the pia-mater descends. These layers are not single, but they frequently subdivide and interlace, and are adapted to each other very exactly, even externally. The depth of the grooves, and consequently the height of the layers, are not everywhere the same. In the place where the grooves are very deep and very long, and where also the adjacent layers are entirely separated from each other, the cerebellum is perfectly divided into several segments, which are called *lobes* (*lobi*).

The best mode of describing the form of the cerebellum, is to examine separately its lateral parts and its centre.

I. LATERAL PARTS.

§ 1738. The two faces of the cerebellum, the upper and the lower, are divided very constantly by deep grooves into several lobes, which are *superior* and *inferior*.

I. UPPER LOBES.

§ 1739. The two lobes of the upper half of the cerebellum, are the *upper anterior* and the *upper posterior*.

1st. The *upper anterior or square lobe* (*lobus anterior, superior, s. quadrangularis*) is irregularly quadrilateral, and narrower forward and outward than backward and inward. It is continuous with that of the opposite side by a central part which is not contracted, and is the highest point of the cerebellum. The two united lobes have a semi-circular form. Their posterior edge is convex and sharp, and is turned backward with the posterior face, while the anterior, which is concave, and which forms at the same time the anterior edge of the cerebellum, considered as a whole looks forward. The blunt extremity, which forms the anterior half of the lateral edge of the cerebellum, looks forward and outward.

This lobe is separated from the upper posterior by a very deep groove, the *superior groove of the cerebellum* (*sulcus superior cerebelli*, Vicq-d'Azyr).

2nd. The *upper posterior or semi-lunar lobe*, *lobe semi-lunaire* (*lobus superior posterior*, s. *semi-lunaris*), comes immediately next the preceding. It forms the posterior and external part of the upper half of each hemisphere. It is semi-lunar, thicker and broader forward than backward; separated backward from the lower posterior by the large lateral groove, and forward from the upper anterior by the upper groove: it is attached inward to the synonymous lobe of the other

hemisphere by a thinner and more sloping part, formed of white substance, called the *commissure of the upper posterior lobes.* The considerable groove between the two upper posterior lobes, forms the commencement of the lower posterior median groove.

II. INFERIOR LOBES.

§ 1740. There are four inferior lobes.

1st. The *posterior or inferior semilunar* lobe (*posterior inferior,* s. *semi-lunaris*), forms the posterior superior and external part of the lower half of each hemisphere. It is separated from the superior and anterior by the large groove, (§ 1737) and from the next by the *inferior external groove* (*sulcus inferior externus*), which is very deep. It is divided by two considerable but more superficial grooves, into three concentric portions which follow one another from behind forward, and diminish in size in the same direction.

The two lateral halves are connected by a narrow and slanting commissure, with which the middle of these three lobes is directly continuous, while the anterior and the posterior only touch on its sides.

The most internal segment has been considered a special lobe, and termed the *small* or *thin* lobe;* but this distinction seems to us inconvenient, because we might just as well consider the middle and anterior segments as so many distinct lobes.

2nd. The *inferior anterior lobe*, the *cuneiform* or *internal inferior* or *digastric* lobe (*anterior inferior*, s. *cuneiformis*, s. *biventer*), is much smaller. It is composed of layers, which proceed almost directly from before backward. It is broader and thicker forward and outward than it is inward, where it at first contracts very much, and then terminates together with the third segment of the preceding lobe, in a very bulging central part.

3rd. The third *inferior lobe*, the *lobe of the medulla oblongata*, the *spinal lobe*, the *monticule* (*lobus inferior internus tonsilla*, Malacarne; s. *lobulus medullæ oblongatæ*, s. *monticulus*, Vic-d'Azyr; *lobus spinalis*, Gordon), is smaller than the preceding, and is composed of layers which proceed directly from before backward, and is convex both outward and inward. Its anterior extremity rests in the restiform body of the spinal marrow (§ 1728). Posteriorly it gives origin to the uvula, which is inserted between the two amygdalæ.

4th. The fourth *inferior lobe*, the *lobe of the pneumogastric nerve* (*flocculus*, s. *lobus nervi pneumogastrici*, Vicq-d'Azyr, *lobus subpeduncularis*, Gordon), arises a little above and before the preceding, from the posterior edge of the peduncle which goes from the cerebellum to the tubercula quadrigemina, directly where this peduncle unites with that which extends from the cerebellum to the medulla oblongata. It arises in this place from a thin pedicle, descends between the auditory

* Malacarne, and Reil, *loc. cit.*, p. 13.

and pneumogastric nerves, and goes forward downward and outward. Almost all of its medullary nucleus is exposed forward and backward, fimbriated in its whole extent outward, and only in its lower part inward, and is covered both outward and inward with grey layers.

The direction of this segment of the cerebellum, is precisely the opposite of that of the others; it is also the loosest.

The two lobes become, upward and inward, a broad semi-circular medullary layer, which rises above on the nodule, and is loose posteriorly, called the *posterior medullary vail* (*velum medullare posterius*). This layer swells on its internal edge, into a thick mass of medullary substance, folded crosswise, and covered with cortical substance, which assists to form the posterior part of the fourth ventricle.

II. CENTRAL PORTION.

§ 1741. Although, strictly speaking, the central part of the cerebellum is no where separated from the two lateral parts, by a want of continuity in the substance; it however differs a little from them in form.

The distinctive character of the formation of this central part is that it is formed by transverse layers and plates, and that except in its middle posterior region, it presents a rounded form bulging from behind forward.

On its anterior face is the most superior part of the cerebrum. The anterior part of its lower face is also very much elevated, but the posterior is lower. Its lateral faces and its anterior part are situated in a large depression, the direction of which is from before backward, which separates the two hemispheres.

The middle region is usually termed the *vermiform eminence* (*vermis cerebelli*), and it is divided into an upper and a lower part.

I. UPPER PART OF THE MIDDLE REGION.

§ 1742. The upper part of the middle region extends from the middle of the posterior edge of the upper face, above the anterior edge to the tubercula quadrigemina.

It is composed of the upper or anterior vermiform process and the cerebral valve.

The upper vermiform process may also be divided into three portions :

1st. The commissure of the two upper posterior lobes.

2nd. The larger upper part, or the *monticule* (*monticulus cerebelli*).

3rd. The lower part which is much smaller, or the *anterior vermiform process.*

The *commissure of the upper posterior* lobes, is thin, narrow, and lower than the lobes it unites.

The monticule, which is the highest part of the cerebellum, curves from behind forward, and from below upward, as high as the posterior edge of the tubercula quadrigemina. It is formed of five segments

placed one after another from behind forwards, they become thicker from before backward, but the third is separated from the others by the deepest transverse grooves. These segments extend from the monticule into all the thickness of the hemispheres; but they gradually contract in approaching the anterior edge, so that the monticule, especially on account of the rounded prominence in its centre, is almost three times as long, as are the lateral edges of the upper face of the cerebellum.

The *lower smaller part*, or the *proper anterior vermiform process*, has a direction the inverse of that of the monticule, that is, it proceeds from above downwards, and from before backward. It is reflected near its posterior extremity at an acute angle, and is continuous with the cerebral valve, on which it rests directly its entire length.

II. CEREBRAL VALVE.

§ 1743. The *cerebral valve*, the *large valve of the brain (valvula cerebri, valvula magna, velum medullare, velum medullare anticum pars anterior veli medullaris)*, arises from the posterior extremity of the anterior vermiform process, and is attached on the sides to the inner face of the prolongations sent by the cerebellum to the tubercula quadrigemina, and terminates by its anterior extremity in the depression between the posterior pair of the tubercula quadrigemina. It contracts from behind forward, becomes thin, and terminates in a convex edge.

Its lower face is smooth. The upper presents porteriorly in nearly all its extent, transverse grooves, which generally extend only to the lateral edges; it is frequently, but not always, divided by a slight longitudinal groove into two equal lateral parts. Its anterior part is much less extensive than the other, and smooth; it is formed in its greater and posterior part, of grey substance. It is also formed anteriorly, at least on its lower face by this substance; we however usually find at its anterior extremity, or directly behind it, on the median line, a white band from one or two lines broad, convex posteriorly and narrower on the sides: it is terminated forward by a small point, which is attached to the groove between the two posterior tubercula quadrigemina. This band generally gives rise to some filaments of the fourth cerebral nerve, but goes mostly only in the upper edge of the anterior peduncle of the cerebellum, and disappears on its outer face.

III. LOWER PART OF THE MIDDLE REGION.

§ 1744. The lower part of the middle region of the cerebellum, commonly called the *inferior vermiform process*, is a little lower posteriorly than the posterior part of the two lower posterior lobes which it unites, although it is not so low as the commissure of the upper posterior lobes situated above it. It is formed of two halves, separated by a superficial transverse groove, and situated one above

the other. It presents a slight prominence in its centre, and is separated by a slightly perceptible contraction from the hemispheres which it unites.

The *central part* or the *pyramid* (*pyramis*, Malacarne) is next to this prominence, and is separated from it by a very deep fissure.

This central part projects in every direction much more than the posterior, and is attached, by much norrower and lower lateral parts, to the posterior half of the inferior external lobe, and to the inferior internal lobe.

Next to the pyramid, from which it is separated by a deep groove, comes a narrow part which is easily divided into several lobes situated one over another, and which generally is not perfectly symmetrical. being turned first to the right, and then to the left. This part also projects still more, in proportion to its breadth, and is continuous with the amygdalæ by a narrow and deeply situated medullary band.

Finally, we next observe the anterior and smallest part, called the *nodule* (*nodulus*, Malacarne), which is continuous on each side, with the posterior valve.

Thus, the central portion of the cerebellum, considered as a whole, is so curved, first from before backward, then from below upward, next from above downward and from behind forward, that the two extremities of the vermiform process, which proceed toward each other, almost touch, and are separated only by the narrow face of the summit of the fourth ventricle.

II. TEXTURE.

§ 1745. The grey substance surrounds all parts of the cerebellum except its lower face, which corresponds to the fourth ventricle; this is covered with medullary substance. The latter is continuous in the three prolongations of the cerebellum, anteriorly with the tubercula quadrigemina, posteriorly with the medulla oblongata, below and on the side, with the annular protuberance and, extends within this organ in ramifications, the collection of which is termed the *arbor vitæ;* to this we may be convinced by vertical incisions.

The medullary trunks follow a more or less curved direction to near the circumference of the cerebellum, and give off, in this course, a greater or less number of branches, which arise from their convex edge.

A thin layer of yellow substance, covered by a thick layer of grey substance, exists on the surface of each medullary branch. This arrangement causes the lamellar structure of the cerebellum, since each layer encloses a layer of medullary substance, and each of the laminæ into which the principal layers divide always corresponds to a medullary substance.

The middle and lower part of the cerebellum presents this arrangement most distinctly. We find in this place seven medullary layers,

three anterior, three superior, and one posterior; the upper of which are the longest, and ramify most simply.

All these layers become much larger from within outward, so that, with their covering of grey substance, they represent cones, the summits of which are turned inward, and the bases unite with the parietes of the fourth ventricle, and are separated from each other forward by deep grooves.

The medullary substance is proportionally much less in the central part, upon which circumstance alone depends its smallness; but externally it accumulates in a direct ratio with the enlargement of the hemispheres of the cerebellum.

§ 1746. A vertical section demonstrates that the medullary nucleus is thickest below, in the centre of the cerebellum, before the summit of the fourth ventricle, opposite the second and third segments, consequently in its anterior half. From this point to the circumference it grows thinner as it ramifies; but we constantly observe that the medullary layers of several lobes are much broader, toward the surface of the organ, than they are when they arise from the central nucleus.

This arrangement is not observed in the fourth lobe, the uvula, the pyramid, the cerebral valve, and the anterior vermiform process; but it is very perceptible in the other two segments. In the anterior lobes of the third segment, the medullary layer, soon after leaving the nucleus, swells out considerably in passing through the lobes. The layer of the upper and the posterior lobes arises from a nucleus, almost as large as the central medullary nucleus, situated before the summit of the fourth ventricle. In the fourth segment we find a similar, but smaller, nucleus, more than six lines long, which is attached to the central nucleus by a thin filament.

§ 1747. In following this method, which is undoubtedly the strictest, we arrive at a new division of the medullary layers of the centre, and of the hemispheres of the cerebellum, very similar to the division mentioned above, but different from it in some respects.

The first of these seven layers belongs to the posterior part of the anterior valve. It is the smallest, and the folds of the posterior part of the valve rest upon it.

The second is formed by the anterior vermiform process, and the anterior part of the upper anterior lobe.

The third is much larger, and belongs to the anterior part of the monticule, and to the larger middle part of the upper anterior lobe.

The fourth, the most posterior, corresponds to the most posterior part of the monticule, to the commissure of the upper posterior lobes, to that of the lower posterior lobes, to the most posterior part of the upper anterior lobe, to the upper posterior lobe, and to the upper part of the lower posterior lobe.

The fifth is composed of the pyramid, of the lower smaller part of the lower posterior lobe, and of the digastric lobe.

The sixth corresponds to the uvula and to the amygdalæ. Finally,

The seventh, forms the nodules and fourth lobe; it is the smallest of all, except the first.

The last two are distinguished from the rest, as they are not cleft and covered with a grey substance, except in one part of their circumference, forward and backward. The first presents this arrangement in every part, and the latter at its upper posterior part. The others are divided several times on each side; they however present traces of the arrangement above mentioned, because the lower anterior half of the segments, which are turned the most forward, and the lower posterior half, which are turned backward, present the most simple and shortest grooves and ramifications, the former downward and backward, the latter downward and forward.

CORPIS FIMBRIATUM.

§ 1748. In the centre of the medullary substance in each hemisphere of the cerebellum, little more internally than externally, we find a rounded, oblong, very vascular body, medullary internally, surrounded with a serrated edge, and intimately united to the medullary substance, called the *rhomboid* or *fimbriated body* (*corpus rhomboideum*, s. *fimbriatum*, s. *dentatum*). Its grey edge mostly surrounds it, except its lower anterior part, where the medullary substance within it is continuous with that of the walls of the fourth ventricle, so that the hemispheres of the cerebellum are consequeutly composed of a double layer of medullary substance, and of grey substance; the internal, formed by the corpus fimbriatum, and the external, comprising most of the external medullary substance and the external grey substance.

We here then find the repetition of what is observed in the medulla oblongata, in the olivary bodies, and the pyramids; (§ 1726-1727) only this form exists here in a greater degree, since the rhomboid body of the cerebellum is not only surrounded with a thin and smooth layer of white substance, as is seen in the medulla oblongato, but this layer is much thicker there, and not only forms several successive ramifications, but is covered a second time with grey substance.

§ 1749. The medullary substance of the cerebellum is extended in three fasciculi, which, however, are not distinctly separated; they are called the *prolongations of the cerebellum* (*crura cerebelli*). One is inferior and descending, another middle and anterior, the last is superior and ascending.

The *inferior descending prolongation* (*crus cerebelli descendens*, s. *ad medullam oblongatam*) blends with the posterior cord of the spinal marrow or the restiform body. The *superior ascending* (*crus cerebelli adscendens*, s. *ad eminentiam quadragesimam*) goes to the posterior tubercula quadrigemina. The middle *lateral* or *anterior* (*crus cerebelli ad portam*) goes forward and downward, and blends with the annular protuberance. Of these three prolongations, the third is the largest. The first two are situated farther inward, and surrounded by it, so that

the rhomboid body exists between it and them. They blend forward and backward, and seem developed principally to form the middle region of the cerebellum, while the hemispheres of this organ rest on the lateral prolongations, so that the medullary layers which form them are directed forward in the upper lobes, and backward in the inferior.

When we separate longitudinally a cerebellum hardened by immersion in alcohol, it is divided into an upper and lower half; we also see on one side a very broad but thin transverse medullary layer, which contracts and at the same time becomes thicker from before, backward and outward, and which is expanded to form the lateral prolongations: we have on the other side, particularly towards the centre, fasciculi which intercross from before backward, so that the ascending and descending prolongations, at least to some extent, are not directly blended with each other, but reciprocally interlace.

§ 1750. The cerebellum forms most of a ring, which is constituted below by the lower part of the annular protuberance, embraces the cerebral peduncles, and unites by its anterior and posterior prolongations, with the medulla oblongata, and with the cerebrum.

III. WEIGHT.

§ 1751. The cerebellum, if separated at the place where its prolongations enter the annular protuberance, the cerebrum and the medulla oblongata, generally weighs five ounces. Its weight consequently, is to that of the rest of the encephalon, as 1 : 8, or as 1 : 7, rarely as 1 : 10, or even as 1 : 11.* In the latter case, we must attribute its excess of weight to the suspended development of the encephalon.

IV. CONSISTENCE.

§ 1752. The cerebellum has about the same consistence of the cerebrum, and like this, it is softer than the medulla oblongata, and harder than the spinal marrow.

ARTICLE THIRD.

CEREBRUM.

I. EXTERNAL FORM.

§ 1753. The *cerebrum* forms most of the cephalic portion of the centre of the nervous system, and occupies its upper and anterior region.

Considered as a whole, its form is a rounded oblong, and it is for the most part convex. Its length exceeds its breadth, and particularly its height. Its greatest length is six inches, its greatest breadth is five, and its height is four. It is broadest and highest in its centre.

* Chaussier, *loc. cit.*, p. 77.

It is formed of two lateral and perfectly similar halves, called *hemispheres* or *lobes* (*hemisphere, lobi*, Chaussier). These two halves are separated at their upper part by a *longitudinal* fissure (*fissura longitudinalis*), much broader backward than forward; in the former direction its breadth is half an inch, but hardly a line in the latter. They are, on the contrary, almost blended with each other at their middle and lower portion.

Each hemisphere is divided into two *lobes*, (*lobi lobuli*, Chaussier), an anterior and a posterior. The anterior is more than twice as large as the posterior. They are separated by a groove more than an inch deep, the direction of which is oblique from above downward, and from behind forward; this is called the *groove of Sylvius* (*fossa Sylvii*), Reil terms it the *valley*. This separation exists only below and on the side, for the groove does not extend to the upper face.

The posterior lobe is also frequently divided into two others, termed the middle and posterior lobe. The latter forms that part of the cerebrum which rests on the tentorium. It cannot be distinguished externally from the middle lobe, but is separated from it on its internal face by a fissure, the direction of which is obliquely from above downward, and from behind forward, and on the lower face by a slight depression.

In each hemisphere we distinguish an inferior, an external, a superior and an internal face.

I. INFERIOR FACE.

§ 1754. The inferior face should be examined first, for we there recognize most distinctly, that the cerebrum is directly continuous with the medulla oblongata.

Of the three faces, this is the most irregular, and its central portion is entirely separated from the two lateral parts.

I. MIDDLE REGION.

I. CEREBRAL PEDUNCLES.

§ 1755. We first observe from behind forward, directly before the anterior edge of the annular protuberance, (§ 1733) the *cerebral peduncles*, or the *crura of the medulla oblongata* (*crura cerebri magna, crura ad medullam oblongatam*). They are two large rounded bodies, about eight lines long, which become much larger from before backward, seven lines broad posteriorly, ten anteriorly, ten lines high, grooved longitudinally, and entirely formed of substance, white externally. They diverge from each other behind forward, and are separated at their lower part by a very broad and deep groove; this is only the anterior groove of the spinal marrow, which is deepened by the development of the peduncles. This part forms above the floor of the aqueduct of Sylvius; its lower face is grey, and numerous vessels pass through it, the direction of which is from below upward, and from without inward. Vicq-d'Azyr* terms it the *middle perforated substance* (*substantia perforata media*).

* *Loc. cit.*, p. 545.

Near the posterior extremity of these bodies there is generally a transverse and slightly projecting band which passes over all their lower face, and crosses the longitudinal groove. A second posterior transverse band is detached from where the anterior and middle prolongations of the cerebellum unite, and is directed from behind forward, and from above downward, between the two peduncles, proceeding on their lower face. This band is situated directly before the annular protuberance, and is often united with it, representing to a certain extent a distinct edge. The cerebral peduncles are covered posteriorly by the anterior part of the annular protuberance, forward by the root of the optic nerve, which turns on them from above downward, from without inward, and from behind forward.

§ 1756. The cerebral peduncles are formed externally by a layer of white substance about two lines thick. Next comes a rounded and elongated layer of blackish substance, which has a semicircular form, as has the whole cerebral peduncle, being concave above and convex below. Next comes a third layer, the thickest; this extends upward to the surface, and is formed of a mixture of grey and of white substance.

§ 1757. Between the anterior extremities of the two cerebral peduncles, is a broad triangular surface, which enlarges very much from behind forward, and is continuous posteriorly with the middle portion, anteriorly with the anterior part of the perforated substance of the lower face. The direction of this surface is from behind forward, and from above downward at its posterior part, from below upward, and from behind forward at its anterior part, which is more perpendicular than the other; it forms the floor of the third ventricle. We remark from behind forward the mammillary eminences, the infundibulum with the pituitary gland, the anterior part of the root, and the decussation of the optic nerve; the rest of it is formed of grey substance.

II. MAMMILLARY EMINENCES.

§ 1758. The *mammillary eminences* or *pisiform tubercles*, (*eminentiæ medullares*, s. *candicantes*, s. *mammillares*, Chaussier) are situated side by side between the anterior extremities of the cerebral peduncles; they are two hemispherical prominences, formed externally of medullary substance, and internally of cortical substance, about half a line distant from each other in their whole height, but separated a little farther posteriorly. They are the inferior and anterior extremities of the fornix.

When attentively examined, we observe that these triangular eminences are each composed of a larger inner, and a much smaller outer half. The anterior and inner faces are straight, the posterior is convex; the latter is the longest, the inner is much the shortest. The two halves of each eminence are very distinctly separated; the internal projects very much; the outer terminates in a point on the outside of the grey substance, between the mammillary eminence and the optic nerve.

III. INFUNDIBULUM AND PITUITARY GLAND.

§ 1759. We find a rounded and conical prolongation between the mammillary eminences, called the *infundibulum*;* this descends obliquely forward, and terminates in the *pituitary gland* or *body* (*hypophysis cerebri*, s. *glandula pituitaria*, Chaussier.)† This is situated in the sella-turcica of the sphenoid bone below the dura-mater, which covers its upper face, and is closely surrounded on all sides. The lower extremity of the infundibulum, is connected with it by a narrow opening in the dura-mater. The lower and the upper parts of the infundibulum are thicker than its centre. In its first two parts it is about a line thick. It is formed of grey substance.

The pituitary gland has an oblong rounded form. It is about six lines broad, three long, and less than three high; it generally weighs, including the infundibulum, eight grains. It is always formed of an anterior and a posterior lobe, which are intimately united. The anterior is very large, and generally twice the size of the other.

The anterior is bean shaped; the posterior is more rounded, and is situated in the posterior and serrated edge of the anterior lobe.

The pituitary body is generally very hard, but its posterior lobe is softer than the anterior.

The anterior lobe is formed of two substances, an external reddish, and an internal which is white, which vary much in their degree of colour and their proportional quantity. We rarely find one which is homogeneous. We observe on the right and left side, on the limit between the two substances, a depression in which those small ducts which arise from the external substance terminate. The posterior part of this depression forms a small canal, which converging with that of the opposite side, goes towards the centre of the posterior edge of the lobes, and the place where the infundibulum is continuous with the pituitary body; the two canals unite in this place.

The posterior lobe has uniformly a more or less greyish tint.

Both lobes are directly attached to the infundibulum, which always descends on the upper face of the pituitary gland to the place where they unite, and are surrounded with it by a prolongation of the pia-mater.

The infundibulum is formed of grey substance, a continuation of that of the floor of the third ventricle, and it is considerably narrower in its centre than above and below where it is several lines thick.

* A. Murray, *Observationes anatomicæ circa infundibulum cerebri, ossium capitis in fœtu structuram alienam partemque nervi intercostalis cervicalem*, Upsal, 1772.

† Wenzel, *Observations sur le cervelet et sur les diverses parties du cerveau dans les epileptiques*, 1811.—Rayer, *Observations sur les maladies de l'appendice sus-sphenoidal du cerveau*; in the *Archiv. gen. de medecine*, t. iii. p. 320.—See also the extract from Guersent's case, same journal, v. iii. p. 312.—Ward, *Case of amaurosis produced by enlargement of the pituitary gland*; in the *Lond. med. repository*, 1823, t. xx. p. 217.

Opinions vary in regard to the nature of the infundibulum; some think it entirely hollow; others on the contrary that it is solid; and some assert that it is sometimes solid and sometimes hollow.

Although a canal is not always visible within it, as some writers have asserted, particularly the old anatomists, and Murray among the moderns, it is sometimes hollow in all its extent, and we can always introduce into it air or liquids, pushing them from the pituitary gland into the third ventricle; but this is more difficult, and even fails when attempted in the opposite direction from the ventricle towards the pituitary gland. The infundibulum may serve to transmit into the cerebral ventricles, a fluid which is secreted by the pituitary gland.

Sometimes, but rarely, we find within or on the surface of the pituitary gland, a solid and sandy substance (*acervulus crebri.*)*

IV. ROOT AND DECUSSATION OF THE OPTIC NERVE.

§ 1760. The larger anterior and inferior part of the root of the optic nerve, which is the largest, and the decussation of this pair of nerves, follow the two bodies, described in the preceding paragraph; these parts are situated outwardly on the anterior extremity of the cerebral peduncles, inwards and in the centre before the greyish plate which forms the inferior wall of the third ventricle, from which the optic nerve receives in the angle formed by the union of its anterior with its posterior half, filaments which may be regarded as its anterior root.

When speaking of the optic nerve, we shall give a more detailed description of the course and union of its roots.

V. GREY PLATE OF THE INFERIOR WALL OF THE THIRD VENTRICLE.

§ 1761. The *grey plate* (*tuber cinereum*) of the inferior wall of the third ventricle, is thicker in its posterior than in its anterior half, which is extremely thin, so that it tears very easily, merely from its weight, when the brain is turned over, and all its sides are not well supported. It is continuous forward with the anterior extremity of the corpus callosum, where it forms on the surface of the anterior commissure a thin expansion, across which we perceive this cord.

II. LATERAL REGIONS.

§ 1762. The two lateral regions of the lower face of the cerebrum, are much more extensive than the central. Their internal edges touch anteriorly and posteriorly where they are separated only by the falx cerebri, while in the centre, there is a space filled by the parts we are about to describe.

This larger part of the lower face of the cerebrum, is formed by the

* Bichat, *Anat. descript.*

lower face of the posterior and of the middle lobe. It presents a slight concavity posteriorly in all that part which corresponds to the posterior lobe, which is entirely covered by the cerebellum. Anteriorly it is slightly convex, loose, and terminated by a rounded extremity. Its anterior part projects considerably, and forms the lowest region of the cerebrum. It extends to the small wings of the sphenoid bone, and passes about an inch beyond the central part, which terminates by the decussation of the optic nerves.

This blunt anterior extremity of the middle lobe is loose, and covers the inferior extremity of the lateral part of the fissure of Sylvius. Behind it, the lower face of the middle lobe forms at first a large convex eminence, which rests outwardly on the base of the skull, and which covers within, the posterior part of the root of the optic nerve, with which it is united only by a short cellular tissue, and by the pia-mater.

This eminence is the commencement of a conical projection, which contracts from before backward, and marks in this place the transition from the external to the internal face of the cerebrum, and forms the posterior part of the inner edge of the middle lobe. The upper part of the eminence, the hook, has a direction from within outward, and from before backward, and terminates in a blunt extremity, which is continuous with the medullary semicircular band. The loose and concave edge of which is turned forward, while its attached and convex edge looks backward. This band called the *corpus fimbriatum* (*tænia, s. fimbria*), enlarges inward and upward. When the cerebellum is turned downward and forward, we see very clearly that it blends with that of the opposite side, and forms the posterior part of the fornix. Below, it is a longitudinal band, which has the same direction, but is less prominent; this is termed the *fascia dentata*. The latter extends forward a little farther than the preceding, and is covered by the external part of the base of the hook. It gradually enlarges from before backward, and presents numerous elevations and depressions situated longitudinally one after another.

The lower part of the internal edge of the lower face of the eminence which has the same direction, but which projects more, extends backward, upward, and inward, and is continuous with the posterior part of the corpus callosum. Its most internal part, which presents a convexity upward and downward, is white and smooth. The grey substance is seen where this internal part is continuous with the lower face of the cerebrum, and there also its circumvolutions commence, at least, unless we consider the *fasciata denta* as a rudiment, which seems more correct, inasmuch as a layer of grey substance, which communicates with the rest of the cortical substance of the brain, passes from each side to the posterior extremity of the corpus callosum on the origin of this inferior medullary layer, and is continuous with the fascia dentata. The circumvolutions arise imperceptibly in this place from the white band which we last described; and the most internal forms a

considerable longitudinal prominence, which is not interrupted by transverse striæ, or at least by none which are very manifest.

The lower face of the anterior lobe, which is slightly concave, and the internal edge of which descends much lower than the external, are situated before the anterior extremity of the middle lobe. The internal edges of the two lobes approach each other very much.

The middle lobe and the anterior lobe are separated by the internal part of the entrance of the fissure of Sylvius. This entrance corresponds entirely to the lower face. Its most internal part is loose, and is continuous with the thin plate situated before the decussation of the optic nerves; (§ 1761.) it becomes broader from within outward, and is perforated with numerous considerable openings, which increase in diameter from within outward, and give passage to the vessels sent off by the origin of the middle cerebral artery into the cerebral substance. This is termed by Vicq-d'Azyr the *anterior perforated substance* (*substantia perforata antica*),* and by Reil, the *cribriform plate* (*lamina cribrosa*)†.

This cribriform plate is formed almost entirely of grey substance. It is, however, white internally in its centre, whence arise the lateral longitudinal striæ of the corpus callosum, which go upward and inward. It is continuous outward and backward at the inner part of the summit of the middle lobe, and farther forward, with a small smooth elevation, about half an inch broad, where the white substance is exposed, and where the anterior and posterior lobes unite, without being separated by a deep fissure.

The olfactory nerve proceeds at a little distance in a deep groove, along the inner edge of the lower face of the anterior lobe; its direction is from before backward, from above downward, and from without inward, and it is united to the lobe by the pia-mater, which extends like a bridge on its upper face.

The extremity of this longitudinal groove, which is much deeper than the optic nerve is high, is bounded by a *triangular* tubercle, the *olfactory tubercle* (*processus*, s. *caruncul s mammillaris*), from whence the nerve partly arises. We also see a white band proceeding from it; this goes backward, upward, and outward, and terminates in the fissure of Sylvius, at the union of the anterior and posterior lobes, at the point where the white substance becomes visible externally.

II. EXTERNAL FACE.

§ 1763. The external face is convex, and is most prominent in its centre on each side upward and downward. It is imperceptibly continuous with the upper and lower faces, less however with the first than with the second. The *fissure* of *Sylvius* divides it into an

* *Loc. cit.*, p. 515.
† *Archiv. für die Physiologie*, vol. ix. p. 199.

anterior and a posterior half. At first view this fissure seems only an indentation, the direction of which is obliquely from below upward, and from before backward, and is situated at about the centre of the lateral face, a little nearer its anterior than its posterior extremity, the parietes of which are formed, the inferior by the upper face of the anterior part of the middle lobe; the superior, on the contrary, by the lower face of the middle part of the anterior lobes, and we may consider its posterior extremity as the upper limit of the external face. An attentive examination, however, soon shows that it has much more extent. In fact, at the outer extremity of the anterior cribriform plate, (§ 1762) the commencent of the fissure of Sylvius, hitherto single, divides into an anterior and a posterior groove. The posterior is that just described. The anterior is much shorter, goes directly upward, and communicates with the posterior extremity of the posterior, by a third groove, which proceeds directly from before backward. These three grooves consequently include a triangular space, the lower part of which is seen where we separate the two parietes of the posterior groove; but we cannot see its whole extent until we have opened the superior horizontal groove, by raising that part of the anterior lobe which forms it anteriorly. We then observe that the central part of the anterior lobe, at first convex, goes from below upward into this middle portion of the fissure of Sylvius, and thus forms a triangular space called the *island of the fissure of Sylvius*, then immediately descends again before its larger upper part, resting upon it, then describes a right angle to go directly outward, for about an inch, and finally joins, also at a right angle, the external face of the hemisphere, and particularly of the anterior lobe. The lower and horizontal face of this reflected portion of the anterior lobe, which may be called the *roof of the fissure of Sylvius*, is situated at the upper face of the anterior and inferior part of the middle lobe, so that it entirely conceals the island.

The latter is about two inches long and an inch and a half high forward. It terminates backward in a blunt summit, and curves outward. We remark on its surface three or four flat circumvolutions, which diverge and enlarge from below upward; the anterior of these are shorter, but broader, perpendicular, and partly also go directly a little forward, while the pôsterior are longer, narrower, and proceed more obliquely backward. Both arise from the right portion, where the two lobes join and emanate as from a common centre of irradiation.

These circumvolutions are separated from those of the middle lobe by a smooth space about four lines broad; but they are so intimately united anteriorly with those of the anterior lobe, that they seem to be the continuation of it.

III. UPPER FACE.

§ 1764. The upper face is very convex from before backward, in which direction it curves uniformly. It is only slightly convex from without inward. It is the longest face of the brain.

IV. INTERNAL FACE.

§ 1765. The upper face forms a right angle with the internal, which is perpendicular and straight. This latter face is placed against that of the opposite side from which it is separated by the falx cerebri. When the two internal faces are separated, we see at their base the upper part of the corpus callosum, which unites them in most of their length.

Behind the posterior extremity of the corpus callosum there is most generally, but not constantly,* a deep groove, almost perpendicular, which may more properly be regarded as the limit between the posterior and the middle lobe, inasmuch as it corresponds exactly to the commencement of the posterior horn of the large lateral ventricle, and lodges the posterior cerebral artery.

V. CIRCUMVOLUTIONS AND ANFRACTUOSITIES.

§ 1766. The upper, the internal, the external, and most of the inferior face of the outer surface of the cerebrum, is uneven from numerous elevations and depressions there seen.

The elevations called *circumvolutions* (*gyri*), from the curves they describe, are situated between the depressions termed *anfractuosities* (*sulci*), so that each is included between two grooves. They are covered in every part, outwardly by a layer of grey substance, which is at most but a line or a line and half thick. They are formed of medullary substance, and hence the latter alone determines the form of the surface of the brain. The external layer of grey substance is single in almost every part; and it is almost always divided, only in a slight extent in the posterior and inferior circumvolutions of the internal face of the hemispheres, by a band of white substance, into an external and an internal layer,† so that the structure of this part of the brain is more complex than the rest. The medullary band is infinitely thinner than the two grey layers, which together are not thicker than a single layer, and of which the internal is sometimes equal to that of the external, and sometimes also greater or less than it. However constant may be this arrangement in this place, we have never found it elsewhere, except in the cornu Ammonis.

* Sœmmerring, *De basi encephali*, tab. iii.
† Vicq-d'Azyr, in the *Mém. de Paris*, 1781, p. 506.

The circumvolutions have a rounded surface, and are situated directly at the side of one another, so that the prominences of one correspond to the depressions of another, although where the angles are very re-entering, the prominent part of an adjacent circumvolution does not perfectly fill them; whence, in many places, particularly in those where large curves are observed, triangular spaces exist, which are included between two circumvolutions. But even in these places, the latter approach or touch at the bottom of the anfractuosities.

These circumvolutions vary much in the manner in which they are continuous with one another.

Their height and breadth are not uniform in every part; the latter generally being some lines greater. They are usually a little more than an inch high, and a little less than an inch broad.

We generally observe in the places where they are broadest, a greater or less depression, which has most commonly, but not always, the direction of the length of the circumvolution, and the depth of which is usually proportioned to the breadth of the latter. This groove evidently marks the division of the circumvolution into two. It is more rare to see analogous depressions extending transversely from one edge to the other.

These circumvolutions are not perfectly similar either in different subjects, or in the two hemispheres of the same cerebrum: they differ, on the contrary, very much, which circumstance may be considered as a character peculiar to the cerebrum of man, since as Vicq-d'Azyr has already remarked,* the cerebrum of the other mammalia, is much more symmetrical. Those on the lower face are much more symmetrical, and more constant than the lateral and the superior. The former are mostly longitudinal, the others have every direction. The anterior and the posterior are generally smaller than the middle.

§ 1766. After describing the parts of the surface of the cerebrum of the brain, which are observed without any derangement of this viscus, and which may consequently be called the *external*, we proceed to describe, in the same order, those which are seen after partially or wholly raising the preceding, according to the situation which they occupy, without having any regard at present to their connections with each other, or with the whole cerebral mass.

I. TUBERCULA QUADRIGEMINA.

§ 1767. The *tubercular quadrigemina* (*eminentia quadrigemina*, s. *bigemina*, s. *nates et testes*), form a square mass, situated forward and laterally between the posterior extremities of the optic beds, below the pineal gland and the posterior commissure, before the cerebellum, and above the cerebral peduncles. This mass is oblique from above downward, and from before backward; it is about nine lines long,

* *Mém. de Paris*, 1783, p. 512.—This subject has been more fully treated by Wenzel, *loc. cit.*, p. 23.

nd ten or twelve broad, and weighs half a drachm. It is composed of two pairs of rounded eminences, situated one after another from before backward. The anterior eminences are usually the largest, and about one line broad. They are called the *nates*, the posterior and the *testes cerebri*. The relation of the eight of the whole mass is to that of the whole cerebrum as 1 : 576. The four eminences are separated by a crucial depression. The anterior are usually more gray than the posterior; this difference of colour is rarely as evident in the cerebrum of man, as in that of several animals, particularly the ruminatia.

The eminences are of a greyish red internally, and are surrounded with a very thin medullary layer, so that the reddish tint they present, depends upon the colour of the grey substance appearing through the external envelop. The layer on which they are placed, is of a much deeper grey, and is continuous with the grey substance of the cerebral peduncles.

A considerable medullary band proceeds from the anterior extremity of the anterior eminences; this goes forward towards the tubercle, which terminates posteriorly the inner face of the optic bed: a second band also extends either directly to the optic nerve, or to the internal corpus geniculatum, or even in part to the external. Another, which is still larger and longer, is detached from the posterior eminences: this goes to the rounded prominence of the lower extremity of the posterior face, that is, to the external corpus geniculatum.

The tubercula quadrigemina, cover the upper part of the cerebral peduncles. They form an arch extended over a small space called the *aqueduct of Sylvius* (*aquæductus Sylvii*), which establishes a communication between the fourth and the third ventricle.

In the bottom and on the sides of this aqueduct, we remark longitudinal depressions, to which we shall return when describing the cerebral ventricles.

A narrow, prominent, medullary band, descends between the two posterior eminences from about the centre: this is situated exactly on the median line, and terminates in the large cerebral valve.

II. PINEAL GLAND.

§ 1769. The *pineal gland, conarium*, Ch. (*Gl. pinealis, conarium*), is an oblong rounded body, much broader from right to left than from before backward, solid, blunt at the extremity, of a very deep grey, sometimes of a reddish colour, from three to four lines long, two to three broad, two thick, and weighing three grains, which always exists in the cerebrum, and which, probably, has not been found, owing to a superficial examination for it. This body is turned from before backward, and is attached anteriorly by its base by two thin medullary cords, which diverge from behind forward to the thalami optici, between which it is situated at their posterior part, but some lines dis-

tant from them on each side. It entirely covers the centre of the upper face of the anterior tubercula quadrigemina. Posteriorly, a medullary layer is detached from its base, which first goes forward, also blends with the upper face of the thalami optici, then immediately curves backward and goes to the point where the anterior pair of the tubercula quadrigemina unite. This is termed the *posterior small cerebral commissure*, which is thinner at its anterior than at its posterior part, the first of which sometimes sends to the pineal gland, filaments similar to nerves, while the second always presents transverse grooves, which soon disappear on each side. The pineal gland always discloses at its posterior part, a small cavity, which varies in size; its orifice is turned toward the middle cerebral ventricle, and the internal face of which is sometimes very manifestly lined by a medullary layer. This cavity is rarely closed in all parts, and its parieties are also proportionally very thick. The variations in its capacity depend neither on the age nor on any other constant condition. It is more consistent than the grey substance generally.

Before this gland, at its circumference, in its cavity, or finally in its substance, and sometimes in all these points at the same time, we find a yellowish substance, which is rarely abundant, but semi-transparent, brilliant, hard, and formed of grains apparently irregular, but which are in fact rounded, and the diameter of which does not exceed half a line. (*Acervulus cerebri*, s. *glandulæ pineales*).*

With some rare exceptions,† this hard substance is constantly found after the seventh year according to Wenzel,‡ and sometimes at least after the sixth, according to our observations. Before this period we find in its place a more viscous mass, which is not more unfrequently found at an advanced age, and which then sometimes even co-exists with the concretions.

In young men the concretions of the pineal gland are usually found only around the organ and in its cavity, while in old men it also exists in its substance, or even only in the latter.

Their colour is not always perfectly the same; generally they have a brighter tint in youth and in advanced age, than during the other periods of life We however observe in this respect, differences which do not depend on the age. The larger calculi are usually darker than those which are small.

In regard to the proportional quantity of these concretions, it is least in youth and in advanced age. In this respect, however, we observe differences which cannot be referred to a determinate cause. The number of the concretions, also, has no direct ratio with the size of the pineal gland.

* Sœmmerring, *De acervulo cerebri*, Mayence, 1785, ed. ii., in Ludwig, *Opp. neurol.*, vol. ii. p. 322.

† We have never known it to be deficient. Wenzel has observed its absence only six times in one hundred cases, (p. 156).

‡ *Loc. cit.* p. 135.

These concretions and the mass which they form, are united with each other, and with the adjacent parts, by a dense cellular tissue, and by an envelope like a sack. The mass is composed not only of a certain number of smaller masses, but each of these latter are formed of several calculi, which are all perfectly round.

Exposed to the air, these concretions become dry, opaque, and whitish. They seem entirely, or almost entirely, similar to the bones in their chemical composition.*

The calculi of the pineal gland, are not a pathological appearance and the cause or the effect of the diseases of the mind,† as Morgagni,‡ Gum,§ and Greding,‖ assert, because they are found in very small quantity in four individuals who were fools.¶ Although they are not unfrequently less abundant than usual, when there is no derangement in the mind; still the coincidence of their rarity with mental derangement, is curious, inasmuch as the fewness of these concretions in young and in old men, seems to lead to something analogous.

III. CORPUS CALLOSUM.

§ 1770. The *corpus callosum*, *mesolobe*, Ch. (*corpus callosum*, *trabs cerebri commissura cerebri magna*),** is situated between the two hemispheres and unites them.

It is nearer their anterior than their posterior extremity, and occupies about the second and third anterior fifths of the length of the cerebrum, considering the length to be divided from before backward into five equal parts. It is, however, a little longer than two fifths.

It is about three inches long and eight lines broad. It gradually enlarges from before backward, but again contracts a little nearer its posterior extremity. In most of its length, excepting the middle, it is covered by the lower part of the internal wall of the hemispheres, which advances on it, whence a deep impression, in form of cul-de-sac, is formed on each side, somewhat analogous to the lateral cavities of the larynx. Its mean thickness is about three lines.

It is uninterruptedly continuous on both sides, with the substance of the hemispheres, and there is no need of recurring to any artificial means to discover that it is formed of transverse medullary fibres, blended with greyish substance.

The anterior extremity of its upper face is convex, and the poste-

* Gordon, *loc. cit.*, p. 135.—Pfaff, who has analyzed these concretions, found them composed of animal matter, and of much phosphate of lime, and a little of the carbonate. See *Deutsches Archiv. für die Physiologie*, vol. iii. p. 170.

† J. F. Meckel, *Mém. de Berlin*, 1751, p. 92.—Rœderer, *De cerebro*, Gottingen, 1758.—Morgagni, *De caus. et sed.*, ep. lxi. a. 3, 4.—Sœmmerring, *loc cit.*

‡ *De caus. et sed.*, ep. v. 12.

§ *De lapillis glandulæ pinealis in quinque mente alien.*, Leipsic, 1753.

‖ *Advers. Med.*, vol. ii. p. 522.

¶ Wenzel, *loc. cit.*, p. 165.

** Reil, *Sur le système et l'organisation du corps calleux*; in the *Archiv. für die Physiologie*, vol. x. p. 171—175.

rior is concave, an arrangement which undoubtedly depends on the separation of the two hemispheres from each other from before backward.

The posterior edge is broader than the anterior.

On its upper face there is a superficial depression which extends through all its length, and corresponds exactly to the median line. Along this depression there is on each side a slight elevation, called the *raphe*, or the *external suture of the corpus callosum* (*raphe*, s. *sutura externa corporis callosi*). The raphe is not formed solely by the artery of the corpus callosum, but it is a sort of cicatrix, produced by the mutual adhesion of the two hemispheres.

Independent of this depression, we also remark on the upper face of the corpus callosum, two longitudinal striæ, generally broader, which proceed on each side parallel to each other, although not perfectly symmetrical; these are called the *lateral longitudinal striæ* (*striæ longitudinalis laterales*) Reil terms them *covered bands*, because they are situated below the part of the hemispheres which projects inward, and which almost entirely covers the lateral part of the corpus callosum.

Transverse fibres exist also on each side, on this upper face: they leave the median line, and are continuous with those of the hemispheres.

We also observe transverse elevations on the lower face; but the latter resemble still more the fasciculi, separated from each other by superficial digressions. They arise from the inferior face of the corpus callosum, being concave and less extensive than the superior. In fact, the transverse fibres extend through all the thickness of the corpus callosum.

These fibres are not transverse at the anterior and posterior extremities of the corpus callosum: they there have a direction from before backward, and from without inward in the first, from behind forward and from without inward in the second, so that they converge.

The corpus callosum is curved at each of its extremities. It is inflected from before backward, and from above downward at its anterior extremity, from behind forward, and also from above downward at its posterior extremity. Reil termed the anterior curve the *knee*, and its extremity the *beak*, the posterior the *glove*. These two curves connect the upper and lower faces of the corpus callosum.

The latter is much more complex than the other. After leaving the knee, it descends from before backward, extends to the anterior commissure, reascends from behind forward, is parallel to the upper face, again proceeds forward, then a third time backward, and is finally continuous with the upper face, after giving origin to the glove.

This lower face is loose only at its anterior and its posterior part, forward from the knee to the anterior commissure, backward to its union with the arch; every where else it is uninterruptedly continuous with the septum lucidum.

The commencement of the lower face from the knee to the ante-

rior commissure, gradually becomes more and more narrow. From the knee to its centre, the upper raphe and the longitudinal lateral striæ are very distinct. But the raphes disappear in this place, the striæ approach each other still nearer from before backward, but do not touch; and at the same time the lower face is grooved from the extremity of the superior raphe to the commissure, where it terminates by a small depression in form of cul-de-sac; consequently the two lateral halves of the corpus callosum are, in this place, less broad, and less flat, and have the form of a straight layer; but their internal faces are inclined one towards another, whence comes the longitudinal groove which we have mentioned.

Hence, also, the part of the corpus callosum, covered by the hemispheres, becomes narrower from before backward, after leaving the knee, so that the most posterior part is entirely disengaged, and it is directly continuous with the ascending internal face of the anterior lobes of the cerebrum. Hence, also, the lateral longitudinal striæ are entirely loose in this place. They are directed backward, downward, and outward, and proceed below and before the anterior commissure, between it and the decussation of the optic nerves. At the posterior extremity of the lower face of the posterior lobe, they unite to the cribriform plate or anterior perforated substance of the lower face of the cerebrum, so that in this place the corpus callosum is continuous, through them, with the lower face of the anterior and the middle lobes; although we cannot term the lateral longitudinal striæ the *peduncles of the corpus callosum*, as has been done by Vicq-d'Azyr.

Posteriorly the corpus callosum is also reflected on itself from above downward, and from behind forward. As the superior face of this reflected portion is adapted to the lower face of the straight portion, it forms what Reil has termed the *glove*.

The septum lucidum is attached to all the rest of the lower face of the corpus callosum, which may be called its *internal* portion, in opposition to the upper and loose part of the inferior, considering the latter as *external*.

The corpus callosum is continuous at is posterior extremity in the posterior and descending horn of the lateral ventricles, partly with the roof of these cavities, partly with the medullary covering of the eminences they enclose, the pes hippocampi minor and the cornu ammonis, which will be described hereafter.

IV. SEPTUM LUCIDUM.

§ 1771. The middle and anterior region of the part of the cerebrum which extends from before backward on the median line, forms the *septum lucidum*,* *septum median*, Ch. (*Septum pellucidum*, s. *lucidum*),† This septum, which is extended vertically between the

* A very improper term, for the septum is but slightly, or even not at all transparent.

† Meckel, *Obs. sur la gland pineale, sur la cloison transparente, &c.* in the *Mem. de Berlin*, 1765, p. 91—102.

corpus callosum and the fornix is triangular. Its height and thickness are much greater anteriorly than posteriorly. It is continuous upward and forward with the anterior, horizontal, and reflected portion of the corpus callosum; posteriorly, but only to a slight extent, with the anterior portion of the fornix, and forms the larger anterior part of the common internal wall of the lateral ventricles.

It is composed of two layers, directly adapted one to another, but they are not fused together. Each of these layers is formed in turn of an external thin and medullary stratum, and an internal thicker and grey stratum, the former of which is continuous with the medullary substance of the corpus callosum, and of the fornix. The medullary layer is lined by a very delicate membrane, which is demonstrated with peculiar facility, when there is an accumulation of serum in the space between the two layers.*

The space between the two layers is the *ventricle of the septum*, called also the *fossa of Sylvius*, the *sinus* of the *median septum*, Ch. (*ventriculus septi*), which is usually termed the *fifth ventricle*, and which Wenzel has called the *first ventricle*. This space does not every where present the same form or the same volume; but generally it is more spacious, and particularly broader in proportion, in the early periods of life, than afterward. Its breadth anteriorly is three or four twelfths of a line in a full grown fœtus. It is usually about an inch and half long in the adult. It is always narrower in its centre, while at the anterior and the posterior extremity, it terminates in a triangular fossa, the angles of which are turned one towards the other.

Opinions are divided on the question, whether this ventricle is entirely separated from the others, or if it communicates with them, whether the communication be constant or simply accidental. Opinions differ also in regard to the position of this opening.

The ventricle of the septum is generally considered as a perfectly closed cavity. Our dissections have demonstrated that in the normal state it is always closed in subjects who are perfectly developed: it however much exceeds the limits generally assigned to it anteriorly; for a canal which is at first rather broad but which gradually contracts, and finally becomes very narrow, extends from its anterior part downward and backward, towards the third ventricle, to near the space between the anterior pillars of the fornix and the anterior commissure. We, however, cannot generally observe the orifice of this duct, although a communication between the third ventricle and that of the septum sometimes exists exactly in this place.†

* Sabatier, *loc. cit.*, p. 433.—Meckel, *loc. cit.* p. 96.—Wenzel, *Prodr.*, p. 7.—Vingtrinier, *Cas remarkable d'hydropisie de la cavite du septum lucidum, ou cavite de Sylvius, chez une jeune fille idiote*; in the *Revue medicale*, vol. viii. p. 299.

† Tarin, *Anthropotomie*, Paris, 1750, vol. i. p. 232. This septum sometimes opens by the small fissure which separates the two cords of the anterior pillar into the lateral ventricles.

V. FORNIX.

§ 1772. The *fornix, trigona cerebral*, Ch. (*fornix*) forms the lower part of the upper and anterior wall of the third ventricle. It is uninterruptedly continuous upward and backward with the corpus callosum, forward in most of its length with the septum. The upper and attached edge is convex; the lower is concave and rests on the internal part of the upper face of the thalami optici, which it almost entirely covers, and is directed from behind forward, and from above downward. Posteriorly, the fornix is continuous by its posterior extremity with the corpus callosum. Externally, but first becoming broader, it joins uninterruptedly the manifestly fibrous envelop of the cornu ammonis, then unites directly forward with the corpus fimbriatum. The posterior part of the fornix presents oblique and transverse striæ in its centre, and has been termed, very improperly, the *lyre*, (*lyra, s. psalterium*), since, as Sabatier has already remarked, the Greek word ψαλλις does not mean a lyre but an arch; hence too the term καμαριων also applied to this part. The origin of the corpus fimbriatum, and the white envelop of the pes hippocampi, are called also the posterior *pillars of the fornix*. We may consider the centre of this latter as its *body*. Anteriorly, the fornix descends directly behind the anterior commissure, then turns backward, and penetrates before and below the optic thalamus of its side, in the floor of the fourth ventricle, where it seems to disappear.

The portion of the fornix between its posterior extremity, and some lines beyond the anterior commissure, is flattened from above downward, and is single. After leaving this point, the fornix becomes cylindrical, and gradually divides into two lateral cords which diverge from above downward, and are called its *anterior pillars* (*crura fornicis anteriora*), so that the anterior commissure which passes before them, is very evident in the interval between them. Each of there cords then glides below the optic bed of its side, in the floor of the fourth ventricle, directly above the decussation of the optic nerves. There, surrounded entirely by grey substance, it goes, first outward, then again inward, so that it describes an arch very convex outwardly, whence opposite the union of the optic nerves, striæ descend into the decussation, where they may be easily followed, and it finally terminates in the grey substance of the mammillary eminences. We may then consider these latter as making part of the fornix, and Santorini is perfectly right* in terming them the *bulbs of the fornix* (*bulbi fornicis*). The fornix, however, does not terminate in this place; for a considerable medullary cord detaches itself from the mammillary eminences; this proceeds within the optic bed, directly behind its internal face, covered in all parts by grey substance, enlarges above and expands in a fan. The mammillary eminences also give off a third medullary cord, which proceeds, at least in great part, nearer the sur-

* *Obs. anat.*, vol. iii. c. 2.

face, on the inner face of the optic bed, goes farther forward, and divides into an anterior and a posterior fasciculus: the posterior follows from before backward the upper edge of the inner face of the optic bed, and is continuous with the peduncle of the pineal gland; the anterior goes outward and is continuous with the semi-circular band, between the corpus striatum and the optic bed. Finally, the mammillary eminences also send backward and outward a thick medullary cord, which is covered by the roof of the optic nerve, and goes to the optic bed.

Thus the fornix represents a very complex chain, which unites the two hemispheres in several parts, and which also establishes a communication between the anterior and the posterior parts of each hemisphere.

VI. THALAMI OPTICI.

§ 1773. The *thalami optici*, or the *posterior cerebral ganglions*, the *optic beds* (*ganglia postica*, Gall, *corpora striata posteriora et superna*, Vieussens; *thalami s. colliculi nervorum opticorum*), are two greyish, elongated, rounded bodies, which converge from behind forward, and from without inward, and are situated before the tubercula quadrigemina, envelop the anterior ends of the cerebral peduncles in most of their extent, especially upward and inward, so as to leave loose only a small part of them outward and downward, if we except the root of the optic nerve; but if we include this root, the cerebral peduncle is surrounded in this place by a complete ring, of which the optic bed is the commencement, and the union of the roots of the optic nerves the termination. These bodies are about an inch and a half long, nine or ten lines high, and from eight to ten broad. They weigh nearly four drachms, so that their weight is to that of the rest of the cerebrum, about as 1 : 36.

Their upper face is convex. We there remark a longitudinal projection, the direction of which is from before backward, and which is most prominent at its anterior part, and which imperceptibly disappears posteriorly. The most prominent part of this projection is the extremity of a large medullary fasciculus, which comes from the mammillary eminences, and expands superiorly like a fan.

The internal face is slightly convex, and almost straight at its anterior part, which is the most extensive,

It is continuous with the upper at an almost right angle. At the anterior part of its union with this latter, we observe a white medullary band about one line and a half broad. The bands of the two sides which are inflected to go to meet each other, unite on the median line, where they become the peduncles of the pineal gland, then go backward towards the mammillary eminences, slightly concealed forward and downward by the inner face of the optic bed.

Behind the posterior extremity of this medullary band, the internal wall is slightly convex, and terminates finally in a rounded prominence.

The optic beds are not united by the nervous substance at their upper part, nor in those subjects which are perfectly developed, nor even at the early periods of life,* although Vieussens,† Santorini,‡ Morgagni,§ Winslow,‖ and Gunz,¶ have asserted the contrary. They are connected in this place only by the pia-mater, which passes from one to the other. But their internal faces adhere anteriorly for the extent of three or four lines, by a small rounded cord, about a line broad, and formed of grey substance, called the *commissura mollis*. Very rarely the commissura mollis,** does not exist;†† hitherto we have known it to be deficient only three times, nor is it common to find two situated one above the other.‡‡

Below there is no continuity of substance between the thalami optici. These two bodies are not united, except by the medium of the floor of the middle cerebral ventricle.

The external face is convex, and intimately united to the corpus striatum, but in such a manner, however, that we everywhere observe between the two eminences, medullary substance, which is the continuation of the cerebral peduncles. The posterior face is also convex, and always evidently divided into three rounded tubercles arranged in a triangle, and situated, one, the *posterior* (*tuberculum ganglii postici posterius, s. posterius superius*), upward and backward; the second, the *internal corpus geniculatum* (*corpus geniculatum internum, s. tuberculum posticum medium*), downward and inward: finally the third, the *external corpus geniculatum* (*corpus geniculatum externum*, s. *tuberculum posticum inferius*, s. *externus*,) still lower and externally.

The posterior tubercle is always larger than the two corpora geniculata, but more connected than they with the substance of the posterior cerebral ganglion.

The two corpora geniculata are sometimes equal in size, but usually the internal is larger. Their form is rounded.

Both are directly connected with the tubercula quadrigemina by medullary bands, which are sometimes blended, but are usually distinct and separate from each other. The medullary band of the posterior tubercula quadrigemina, goes to the external corpus geniculatum, and that of the anterior to the internal corpus geniculatum. The first is much more constant and stronger than the second.

The two corpora geniculata are composed only of medullary sub-

* At least we have always observed this. Sabatier has made the same remark, (*Anat.*, vol. iii. p. 437.)

† *Neurogr.*, l. i. c. ii.

‡ *Obs. anat.*, c. iii. § 7.

§ *Advérs. anat.*, l. vi. c. x.

‖ *Exp. anat.*, l. iv. p. 63.

¶ *Prolusio de cerébro'* ii. Leipsic, 1750, p. xi.

** Morgagni and Gunz claim the honour of its discovery.

†† Wenzel has known it to be deficient five times out of sixty-six, (*De cereb.* p. 129.) Gordon (p. 98) has always found it, and Sabatier almost always (p. 437).

‡‡ Vicq. d'Azyr, p. 527.—Wenzel, *Prodr.* p. 15.—We also have observed this anomaly.

stance externally. Internally they are formed by a mixture of white and of grey substance.

They are continuous downward with the root of the optic nerve.

The upper and posterior face of the optic bed, is covered with a thin layer of white substance ; the internal of grey. Internally they present a mixture of white and of grey substance. Beside the medullary fasciculi from the tubercula quadrigemina, and which partly remain in the substance of the ganglion, partly also blend in its surface with the pineal gland, this body is formed of several superimposed layers, the rays of which are directed from within outward, unite in the substance of the cerebral peduncle, and intimately interlace with it.

VII. CORPORA STRIATA.

§ 1774. The *striated bodies, beds of the ethmoidal nerves*, Ch., *anterior cerebral ganglions*, Gall, (*corpora striata, corpora striata antica inferiora, ganglia cerebri magna antica*),* are two elongated, rounded and flat bodies, formed almost entirely of a substance very grey ex-externally, which occupy most of the lateral ventricles and the lower part of the anterior lobes. They are usually about two inches and a half long, and their greatest height is about one half of it. They are from eight to nine lines thick, and are highest and thickest anteriorly; they gradually become thinner and lower posteriorly. The mean weight of each is about five drachms, and is to that of the optic bed as 5 : 4. The weight and proportional size of these two eminences are, however, not always the same, as has been determined by Vicq-d'Azyr and Gordon, with whose observations our own agree. Their weight is to that of the whole cerebrum as 1 : 29. Their greatest diameter is from before backward, and from within outward. They are nearly four lines distant from each other forward, and about two inches posteriorly; because posteriorly the thalami optici and the tubercula quadrigemina exist between them, while anteriorly they are separated only by the septum, and the anterior part of the fornix.

Their upper and their internal portions are loose and unattached to a considerable extent; this forms the floor, and the outer wall of the anterior horn of the large cerebral ventricle, has a conical form, is gradually elongated from before backward, where it is pointed, and describes in its centre a considerable curve, the direction of which is from before backward. After leaving the external edge of this loose part, the medullary substance is reflected from below upward at an acute angle, and forms the lateral and upper walls of the large cerebral ventricle. When cut from within outward, proceeding from this edge, we arrive only into the medullary substance of the hemispheres, but if the incision is made downward and a little outward, we come to the

* Magendie, *Note sur les fonctions des corps striés et des tubercules quadrijameaux*; in the *Journ. de phys.*, vol. iii. p. 376.

outer face of the corpus striatum, which makes an obtuse angle with the superior. This external face extends to near the entrance and the island of the fissure of Sylvius, from which it is only a few lines distant. Its upper part is straight, and formed from behind backward by a layer of medullary substance about four lines broad. The lower is convex in almost all its extent, composed of grey substance, and but loosely connected with the medullary substance of the posterior part of the anterior lobe, in the midst of which it is imbedded, so that the corpus striatum can easily be detached from this latter. Only the posterior part of the lower half of the external face is also straight and medullary, because the white band we have mentioned is reflected downward and forward; but at its most posterior part it again becomes grey, and here the grey substance, which is visible externally above, forms a tail, which is inflected downward and forward in the same direction as the medullary substance, but does not, however, extend to the anterior large half of the external grey face.

The grey substance of the corpus striatum seems then to be divided externally by a considerable layer of medullary substance, into an internal and upper half, and an external and lower.

The inferior face of this body is narrow and rounded. It is imperceptibly continuous with the internal and the external. Below it is blended with the medullary substance of the hemispheres, which gives it a whitish grey tint.

The lower part of the internal face is convex, and closely envelops the external face of the optic bed.

Horizontal, vertical, and oblique incisions make us acquainted with the essential characters of the structure of the corpora striata. They demonstrate that these bodies are composed of three substances, one a deep grey, the second a light grey, and a third medullary, which form several alternate layers.

All these layers describe arches, the convex edges of which are turned upward, and the concave edges downward.

The medullary substance proceeds from behind forward, and from below upward, from the cerebral peduncle and the optic bed to the middle of the grey substance. At its entrance, which corresponds to the posterior extremity of the lower face of the corpus striatum, it extends its whole height; but it soon divides into several fissures and superimposed layers, which are generally three in number, which go forward; the lower two of these are much narrower and shorter than the upper. The latter, which also extends farther forward than the other two, does not proceed except to the upper and posterior part of the loose face of the corpus striatum, while forward and downward it is entirely enveloped by the grey substance which forms its anterior extremity. At the same time its breadth diminishes forward and downward, and it is interrupted by some grey substance both from before backward and from above downward, so that it is divided below into several layers of small white rays, some of which occur also between

the third and second layer. This white substance, however, penetrates from behind forward, and from below upward, through the grey, and is continuous in every direction with the medullary substance of the hemispheres.

The light grey substance forms the middle and lower part of the corpus striatum ; it is situated between the inferior and the first medullary layers, and likewise between this and the second, which it much exceeds in thickness. It occupies the smallest part of the corpus striatum.

Most of this body is formed of a deep grey substance, which is abundant, particularly above, where it occupies the space between the second and third medullary layer, and forms the loose part of the corpus striatum, situated above and before this space.

The corpus striatum is then formed by alternate layers of white and grey substance; all these layers are conical. Those of grey substance bulge forward, and those of white substance backward. All terminate in a point at the opposite extremity, and interlace with each other.

The light grey substance which forms the middle and lower part seems to be formed by an imperfect separation of white and grey substance; for the two lower layers of white substance are not so pure a white as the upper, which are contrasted with a deep grey substance.

The best method of becoming acquainted with the structure of the corpus striatum, is to cut and scrape its posterior and inferior part, and follow the medullary substance of the cerebral peduncle within it. The cerebral peduncle enters it from below upward, and from behind forward, and the medullary substance, with which it is continuous, is enveloped directly downward, inward, and outward, by the grey substance; the corpus striatum is interrupted by this only in a small portion of its posterior extremity.

The medullary substance of the cerebral peduncle disappears at the posterior extremity of the corpus striatum, like the branches of a fan, in the form of fasciculi, which penetrate the grey substance in all parts, enlarge from before backward, and become thin from within outward. It sends outward and inward numerous radiating and pointed prolongations which expand in the grey substance, but do not extend to the circumference.

The grey substance of the corpus striatum is then divided in its whole extent by the white, which is continuous with the cerebral peduncle, into two parts, an external and an internal, which are blended together below, but not above. The white band of its upper face is the anterior edge of the medullary expansion which passes through it; and the commencement of the medullary substance of the hemisphere formed by the white substance which passes through the middle of the corpus striatum.

As the medullary substance gives off in its course expansions which radiate in every direction, the corpus striatum ought necessarily to

present internally the appearance described adove, when cut transversely and longitudinally; so that it much resembles the cerebellum, from which also the medullary substance disappears in thin layers, only there the grey substance which covers the latter, instead of having the same form, merely appears as a layer which is expanded uniformly over its surface.

VIII. TŒNIA SEMICIRCULARIS.

§ 1775. In the groove between the upper faces of the corpus striatum and the optic bed, is a narrow and prominent band, called the *tœnia semicircularis* (*stria cornea*, s. *terminalis*, s. *tœnia striata*, s. *geminum centrum semicirculare*). This band is a little more than a line broad and is slightly prominent; it commences before the foramen of Monro, near the anterior pillar of the fornix, with which it is always connected. It rarely terminates at the posterior extremity of the corpus striatum: it generally curves downward and outward, and disappears near the end of the roof of the descending horn of the lateral ventricle, where it communicates with the summit of the corpus fimbriatum in the descending horn of the great ventricle, and the most external fibres of the corpus fimbriatum and of the anterior commissure.

This band projects but slightly in the early periods of life: is whitish, and formed of longitudinal fibres, which raise in this place the inner membrane of the ventricle. It afterwards becomes, particularly on its inside, more prominent and brownish, and there is deposited on the surface of the medullary fibres primarily existing, and which alone form it at the commencement, a more or less brownish layer, which is hard and solid, whence it is called the *lamina cornea*. This change ensues as the subject grows older, or cephalic affections exist; so that it is not essential to the organization of the band. Tarin considers this substance as of a peculiar nature.* Vicq-d'Azyr regards it as the common grey substance.† Wenzel has attended particularly to its formation, and considers it as formed by an effusion of fibrin, and as it is developed, the adjacent membrane of the ventricles also thickens, and the number of the glands of Pacchioni increase.‡

IX. ANTERIOR COMMISSURE.

§ 1776. The *anterior* (*commissure commissura anterior*, s. *magna*,)§ is a transverse, rounded, medullary fasciculus, which is slightly flattened from above downward, and is a little thicker than the optic nerve: it is enclosed in a sheathe formed from the pia-mater, and is situated directly in front of the anterior peduncles of the fornix. Its anterior part is loose and exposed, but on the right and left the cord pene-

* *Advers. anat.* 1750, p. 2.
† *Loc. cit.*, p. 430.
‡ *Loc. cit.*, p. 82.
§ Reil. *Archiv. für die Physiologie*, vol. xi., p. 89,

trates into the lower and anterior part of the corpus striatum; is a little broader, becoming also gradually thinner; goes outward, then backward, and a little downward, and thus describes an arch which is convex forward. This arch passes through the substance of the corpus striatum, but does not blend with it, and is situated in a special canal from which it is grooved. After leaving this transverse canal, it vanishes in rays, and terminates in the lower region of the fissure of Sylvius, and of the descending horn of the lateral ventricle, where it blends with the most external fibres of the corpus fimbriatum and tœnia semicircularis.

Only the middle part of the anterior commissure is then perceptible, and even this to a very slight extent without, if none of the cerebral substance be removed.

This cord unites the anterior and inferior parts of the posterior lobe of the two hemispheres, and forms the anterior part of a ring which is closed posteriorly by the fornix, its appendages, and the tœnia semicircularis.

It is, however, very probably connected with the origin of the olfactory nerve, since it passes above the anterior cribriform plate, at a little distance from its roots, especially the external, and an undoubted relation between the development of these roots and that of the commissure, may be demonstrated in animals. Hence the origin of the optic and olfactory nerves very much resemble each other.

The structure of the anterior commissure is extremely curious, since it resembles a nerve, not only being surrounded externally by a thin neurilemmatic envelop, but is also formed internally by fasciculi of a very minute cellular tissue. The external and internal envelops do not disappear, except at the place where the commissure vanishes on leaving the corpus striatum.

X. CEREBRAL VENTRICLES.

§ 1777. The substance of the cerebrum is not perfectly solid. It encloses a considerable space, which corresponds generally in form to that of the external face, because it proceeds into all parts of this viscus, but its extent is much less. We may term this space generally the *cerebral ventricle* (*ventriculus cerebri*), or the *central fissure* (*fissura centralis*).

The floor of this cavity is formed by that part of the cerebrum which corresponds to the anterior cords of the spinal marrow, and of which it is properly only a development. Its sides and roof are formed by the parts superadded to these cords.

It begins at the posterior extremity of the upper face of the medulla elongata in the place where the posterior cords of the spinal marrow separate, and is here called the *rhomboidal sinus*, or the *calamus scriptorius;* it continues then under the cerebellum, where it gives rise to the *fourth ventricle*, dilating in every direction: thence

it contracts and passes under the tubercula quadrigemina, and forms the *aqueduct of Sylvius;* it then again enlarges in every direction, principally, however, from above downward, between the thalami optici, where it forms the *third ventricle,* terminates anteriorly in this place in a cul-de-sac, but extends much to the right and left, and thus forms on each side the *lateral ventricle.*

The cerebral ventricle, considered as a whole, has the form of a cross, the anterior longitudinal arm of which is considerably shortened, while each of the lateral ones is divided into three arms.

All the different compartments communicate uninterruptedly with each other.

This cavity is not entirely closed. Its internal face, and consequently that of the cerebrum, communicates with the external in many parts, viz. backward, between the cerebellum and the medulla oblongata by the *small transverse fissure (fissura cerebri transversa parva);* and forward, between the corpus callosum, the corpus fimbriatum, the tubercula quadrigemina, and the thalami optici, by the *large transverse fissure (fissura cerebri transversa magna).* These spaces, however, which are caused by the interruption of the cerebral substance, are filled by the arachnoid membrane and the pia-mater.

The parietes of these different cavities are smooth, and moistened with serum. Many anatomists* admit here only the choroid plexus, and no special membrane. Bichat† and Wenzel,‡ on the contrary, whose opinion is more correct, have there found a special membrane, which is, according to the former, a continuation of the arachnoid membrane, while the latter regards it as a membrane of a particular character. The internal membrane of the first, second, third, and fourth ventricles is evidently continuous with the arachnoid; but that which lines the fifth forms a closed sac. This circumstance, however, proves nothing against Bichat's opinion, since the ventricle of the septum probably communicates with the others at first.

The inner membrane of the cerebral fissure is demonstrated with peculiar facility in youth, when the medullary substance above the lateral ventricles is carefully removed. It may be easily demonstrated also§ in the ventricle of the septum or the corpora striata, in the posterior horn of the large ventricles, and on the floor of the fourth. It usually becomes thicker in hydrocephalus internus. Sometimes also it is very evident when serum accumulates between it and the cerebral substance. It can rarely, however, be separated completely, and some cerebral substance almost always adheres to its external face. Hence why many anatomists have termed it the *medullary layer* (*lamina medullaris*). Very recently, also, Reil has applied the term

* As Sœmmerring, *loc. cit.*, p. 48, § 59.

† *Tr. des membranes*, p. 216.

‡ *Prodromus*, § 8, p. 8. *De cerebro*, cap. viii. *Integumentum ventriculorum cerebri et partium in iis sitarum*, p. 80.

§ Wenzel, *loc. cit.*, p. 81.

epithelium to the union of this membrane with the shapeless substance which covers the parts of the cerebrum below it.*

Its thickness also varies in the normal state in the different regions where it is considered.

Of the divisions comprised by the cerebral ventricle, we have already described the rhomboidal sinus (§ 1729): we have then only to examine the others.

a. Ventricle of the cerebellum.

§ 1778. The *ventricle of the cerebellum*, the *fourth ventricle*, the *fifth ventricle* (*ventriculus cerebelli, ven. quartus*, s. *quintus*, Wenzel),† is triangular: its base looks downward and backward, and its summit upward and forward. It is continuous downward and backward with the rhomboidal sinus of the medulla oblongata. It penetrates backward and upward between the anterior and posterior extremities of the vermiform process in the substance of the cerebellum, and terminates there in a point. Anteriorly it passes under the posterior edge of the tubercula quadrigemina, and is continuous with the aqueduct of Sylvius. Its floor, which in the natural position of the cerebrum, constitutes the anterior wall, is formed by the upper face of the annular protuberance. Along the median line is a longitudinal groove about one line deep; on each side of this rises a prominence which turns over from within outward.

From the anterior to the posterior extremity of this floor a narrow and elongated *blue place* extends, which probably exists only in man; this is formed of numerous minute blood-vessels, and is apparently connected with the origin of the auditory nerve.‡

The posterior and inferior wall is formed by the anterior and internal face of the posterior half of the vermiform process, and laterally by the posterior valve. The lateral walls are composed of the anterior and middle prolongations of the cerebellum. Finally, the superior is formed posteriorly by the posterior face of the anterior half of the vermiform process, and anteriorly by the anterior cerebral valve.

The fourth ventricle is open posteriorly, so that in this place the inner face of the cerebellum is continuous with the external by the *small cerebral fissure*.

* *Archiv. für die Physiologie*, vol. ix. p. 143.

† Desmoulins, *Mémoire sur le rapport qui unit le développement du nerf pneumogastrique à celui des parois du quatrième ventricule*; in the *Journ. de phys. exp.*, vol. iii. p. 362.

‡ *Loculi cærulei in basi ventriculi quinti*; in Wenzel, *loc. cit.* vol. xvii. pp. 168, 169.—This blue place has already been described by Vicq-d'Azyr, in the *Mém. de Paris*, 1781, p. 585.

b. Aqueduct of Sylvius.

§ 1779. The *aqueduct of Sylvius* (*aquæductus Sylvii*, s. *canalis eminentiæ quadrigeminæ*), is a very narrow channel, which establishes a communication between the ventricles of the cerebrum and cerebellum. It is formed below by the upper and convex face of the cerebral peduncles, on the sides and above by the tubercula quadrigemina, and anteriorly by the posterior commissure and the pineal gland. It is continuous posteriorly with the fourth ventricle, anteriorly with the third, and also communicates in the latter place with the external face of the cerebrum.

The parietes of this canal present four longitudinal depressions, an inferior, two lateral, and a superior.

The inferior is the most posterior, and is situated in the median line: it terminates the longitudinal groove in the floor of the fourth ventricle. The lateral are situated farther forward, become deeper towards the centre, and converge from behind forward. The superior, which corresponds exactly to the inferior, and which passes through the centre of the upper face, is the deepest: it is broader anteriorly and still deeper posteriorly.

We do not consider these depressions as particularly important, as Wenzel thinks them. We regard them only as the remains of the large ventricle covered in the fœtus by the tubercula quadrigemina.

c. Third ventricle.

§ 1780. The *third ventricle* (*vent. tertius*, s. *processus fissuræ medianæ perpendicularis*, Gordon), commences at the anterior extremity of the aqueduct of Sylvius, and descends obliquely from behind forward. It is much larger than the fourth ventricle in man, while in animals the reverse is true.† Its form is very irregular, resembling an oblong square. Its length is much greater than its height, and it is only a few lines broad.

Its floor is formed by the grey substance situated before the cerebral peduncles by the mammillary eminences, finally between and before the latter, by the decussation of the optic nerves. Its anterior face is covered by the thin layer of grey substance situated before the decussation of the optic nerves, by the anterior peduncles of the fornix, and by the anterior commissure. Its upper wall or roof is covered by the body and the posterior peduncles of the fornix, and also by the posterior fold of the corpus callosum. Finally, its lateral walls are formed below by the internal, and above by the external faces of the thalami optici. Its lower face is the most irregular: considered

* Wenzel, *Scrobiculi in canali corporum quadrigeminorum.* *Loc. cit.*, vol. xvi. pp. 166, 167.

† Wenzel, *loc. cit.*, cap. 21, 22.

generally, it descends from behind forward; but we remark in it two culs-de-sac, the posterior of which is the commencement of the infundibulum, and the anterior is situated before the decussation of the optic nerves. Both of these depressions terminate in a point.

The fourth ventricle is imperfectly divided near its centre, posteriorly into an upper and a lower half by the commissura mollis of the thalami optici.

The anterior, superior, and inferior walls are perfect, but the lateral presents a space, or rather the anterior and the superior lateral walls are not united by cerebral substance. The middle and lateral ventricles of the cerebrum communicate by this space between the optic beds and the fornix. When the pia-mater and arachnoid membrane to which it gives passage are removed, it is quite large, but when these two membranes continue in place it is very small, and forms a very narrow opening between the lower anterior extremity of the thalami optici and the anterior pillars of the fornix.

This opening is called the *foramen of Monro (foramen Monroi)*.

It is constant, except in certain pathological states. The impossibility of passing air from one of the lateral ventricles into the other, the permanent fullness of one of these cavities after the other has been opened and the fluid removed from it, and finally the difference sometimes remarked between the liquids accumulated in the two lateral ventricles,* have been adduced as arguments against its existence. But most of these phenomena may be explained by the falling of the vascular plexus across the opening, and also by the morbid adhesion with the edges of this latter, or of the edges themselves.† This latter cause is more probable, as most of the observations on which the above mentioned arguments rest have been made in circumstances favourable to a morbid adhesion.‡

We must not confound with the foramen of Monro an opening admitted by incorrect anatomists in the septum lucidum, which does not exist; when this is seen, it depends on the awkwardness of the anatomist, the bad condition of the cerebrum, or a morbid laceration.

In fact the third ventricle is continuous upward and backward with the aqueduct of Sylvius; but it also communicates with the external under the posterior extremity of the corpus callosum, above and before the pineal gland, through a broad opening of which the pia-mater and the arachnoid membrane which penetrate into the cerebrum, contract the diameter, and which forms the central part of the large cerebral ventricle.

There is consequently in this place, about the centre of the encephalon between the cerebrum and cerebellum, a point where the external face of the cerebrum is continuous anteriorly and posteriorly

* Portal, *Sur une hydropsie particulière des ventricules latéraux du cerveau et sur la cloison qui les sépare*; in the *Mém de Paris*, 1770, p. 240.
† Monro, *On the brain*, Edinburgh, 1793, ch. 1.
‡ *Vicq-d'Azyr*, in the *Mém. de Paris*, p. 539.

with the internal by means of the third ventricle, and from before backward by the aqueduct of Sylvius.

d. Lateral ventricles.

§ 1781. The *lateral*, *anterior*, or *large ventricles* (*ven. cerebri laterales*, s. *anteriores*, s. *magni*, s. *tricornes*,* are situated in each hemisphere, on the sides of the corpus callosum, the fornix and the septum. They have an rregular and generally oblong form, being arranged so that their greatest length extends from before backward. Above they do not pass beyond the corpus callosum, and that part of the hemispheres into which the body extends. They form their roof, which must not be described as a separate and distinct part from the rest of the cerebral substance.

We may distinguish in it a *middle part*, and *horns* or *curves* (*cornua*).

The middle part proceeds directly from behind forward, and from above downward. It is continued inward by the septum lucidum and the corpus callosum, outward by the corpus striatum. Its floor forms most of the fornix.

1. Anterior horn.

§ 1782. The *anterior horn* is the smallest. It goes outward and downward. It is convex forward, and concave backward. It is situated between the anterior wall of the ventricle, and the anterior extremity of the corpus striatum.

2. Posterior horn.

§ 1783. The *posterior horn*, and the *inferior* or *descending horn*, are detached from the posterior extremity of the central part.

The *posterior horn*, the *digital depression* (*fovea digitata*), terminates imperceptibly in a blunt point, goes rather directly backward, although it inclines also a little outward, and extends almost to about an inch from the posterior extremity of the hemisphere: its length, however, varies much.

The internal wall, and always that alone, presents in its inside a considerable eminence, called the *digital eminence*, the *spur*, the *nail*, the *pes hippocampi minor* (*eminentia digitalis*, *calcar*, *unguis*.† This eminence is very constant. We have always found it in the numerous brains we have dissected. Wenzel, out of fifty-one subjects dissected

* Haase, *De ventriculis cerebri tricornibus*, Leipsic, 1789.—Rudolphi, *De ventriculis cerebri*, Gripswald, 1796.

† Morand, *Obs. anat. sur quelques parties du cerveau; in the Mém. de Paris*, 1744, p. 430.

for this purpose, found only three in whom it was deficient on both sides, and two where it appeared on one side only.*

This part bulges a little at its centre, and terminates posteriorly in a rounded extremity, which gradually becomes thinner. It is very constant in respect to its existence and situation: but its form and volume differ considerably, even in the two hemispheres of the same cerebrum.

Its form is sometimes narrow and elongated, and sometimes broader. It is generally smooth; but it sometimes presents several transverse grooves, especially posteriorly, or is divided by a longitudinal groove into two halves, the upper of which is generally the larger.

Its size is usually in direct ratio with the development of the posterior horn. But there are exceptions to this rule, for a very small horn often encloses a very large eminence, while another which is very large may contain one which is hardly perceptible.

The structure of this eminence is generally homogeneous. It is composed of one circumvolution and a half: a small triangular groove arises from the bottom of one of the cavities between two adjacent hemispheres, on the inner face of the posterior cerebral lobe; its summit is turned upwards, and its medullary substance is continuous with that of the inner face of the posterior horn. Its grey substance is blended with a layer of cortical substance, situated directly below the white substance which covers the internal face of the posterior horn, and forms with this latter the inner layer of the pes hippocampi minor. The medullary layer of this eminence is continuous upward with the white substance of the circumvolution above, as the grey substance also is continuous with the grey substance of the circumvolution which follows it.

This arrangement is easily recognized when we cut the pes hippocampi minor transversely.

There is then a resemblance in regard to form between the external circumvolutions and the pes hippocampi minor: this disappears or at least becomes smaller when the pia-mater is removed.†

3. Descending horn.

§ 1784. The *descending* or *lateral horn*, the largest of the three horns of the lateral ventricle, is convex outward and concave inward. It goes downward and forward in the external face of the cerebral peduncle, and occupies the lower, inner and anterior part of the middle lobe; but it does not extend to its extremity, for it terminates half an inch behind it.

On its lower face are two large eminences, the *cornu Ammonis* and the *corpus fimbriatum.*

* *Loc. cit.*, pp. 144, 145.
† Wenzel, *loc. cit.*, p. 146.

The *cornu Ammonis* or *pes hippocampi* (*cornu Ammonis*, s. *arietis*, s. *pes hippocampi, protuberantia cylindrica*, Ch.) is convex externally and concave internally, and rests on the lower face of the descending horn. It gradually becomes broader and higher backward than forward. Its anterior extremity, which is also that of the descending horn of the lateral ventricle and is considerably broad, curves inward and usually but not always presents from two to five longitudinal notches. The loose face of the cornu Ammonis is medullary, and longitudinal fibres are often very distinct in this layer of white substance, which is otherwise so thin that the grey substance which forms most of the protuberance is easily distinguished.

Sometimes, but rarely, we find a second eminence, which varies in length, at the side of and behind the cornu Ammonis, so that it seems divided into two parts situated one above the other. This eminence is termed the *collateral eminence* of Meckel (*eminentia collateralis Meckelii*), and seems to arise from suspended development.

On the inner and concave side of the cornu Ammonis is a narrow falciform medullary projection, which is perfectly parallel to this side, but less broad than it, and terminates in an inner loose and sharp edge on which the large choroid plexus rests. This is termed the *corpus fimbriatum* (*tænia*, s. *fimbria*). This body ceases about an inch before the large cornu Ammonis, and terminates imperceptibly in a circumvolution of the cerebrum.

At the side of the corpus fimbriatum, but farther inward and backward, consequently a little covered by it, but situated out of the descending horn, is another analogous and shorter body of grey substance which exists in the depression between it and the inner descending edge of the large lateral horn: this is the *fascia dentata*.

The loose edge of this small eminence is divided from above downward by numerous transverse incisions or folds into about twelve or fourteen small segments, which give it a waved appearance; these disappear on removing the pia-mater.

A transverse incision across the parts within the descending horn shows that the cornu Ammonis is covered on its upper and lower faces by a medullary layer, which terminates above in the corpus fimbriatum, and which penetrates farther inward below and is reflected in the medullary substance of the lower face of the horn.

Next to this medullary layer comes another of grey substance which is much thicker, being as thick as that on the surface of the cerebrum; this exactly covers the preceding, and is continuous with the cortical envelop of the encephalon. The upper face, which is farther from the median line, and consequently forms the outer part of this grey layer, is the fascia dentata. The internal is continuous with the grey substance of the inner face of the lower part of the posterior lobe of the cerebrum.

Between this internal and this external part a thinner medullary layer is interwoven; this enlarges above where it is loose and unattached.

These parts are then evidently similar to the corresponding halves of two adjacent circumvolutions, between which a medullary layer penetrates instead of the pia-mater alone, and which is covered internally only by a very thin medullary layer.

The thin medullary layer which covers the grey substance is continuous in all parts with the rest of the white substance, but that which exists before the lower face of the cornu Ammonis is always separated in every part from that opposite, which covers the upper face of the eminence and is inflected only at the upper part to go and meet it. If these adhered, this lower layer and this inner layer of grey substance of the cornu Ammonis, united to the floor of the descending horn of the lateral ventricle and to the substance below, would form a complete circumvolution.

The medullary envelop of the cornu Ammonis is continuous with the posterior part of the corpus callosum, and partly also with the posterior pillar of the fornix. The whole corpus fimbriatum passes into the latter.

The lateral ventricles are enclosed and enveloped by cerebral substance in most of their extent, which is uninterrupted.

This is true particularly of the anterior horn and the posterior horn. On the contrary, the middle region and the lower horn are interrupted in a considerable part of their extent, since the fornix and the corpus fimbriatum are not united to the adjacent parts. From this arrangement it follows that the middle region communicates from above downward and from without inward with the third ventricle: that the descending horn is in relation with the external face of the posterior cerebral lobe, and consequently that there is between the corpus fimbriatum and the posterior part of the optic beds, a space which forms the two sides of the large cerebral fissure, with the central part of which it is blended internally. If we then separate the edges of this space which is filled by the arachnoid membrane, and also by the pia-mater and the cellular tissue, we arrive at the descending horn of the lateral ventricle and the third ventricle without cutting the cerebral substance; thus by slitting the roof of the descending horn from within outward, we can reflect from behind forward all the posterior part of the hemispheres with the corpus callosum and the fornix.

II. TEXTURE.

§ 1785. The cerebrum is the developed and expanded anterior part of the spinal marrow.

The two lateral cords of this anterior part intercross and form above the decussation, the pyramids, which project very distinctly on the lower face of the medulla oblongata.

At their sides is a narrower fasciculus, the fibres of which divide below the olivary bodies into an anterior and a posterior layer, which surronnd these eminences, above which they again unite to enter the annular protuberance.

The third fasciculus is the largest. It is situated inward and backward at the side of the preceding. It forms the floor of the calamus scriptorius and of the fourth ventricle, where it is covered by the grey substance.

These three fasciculi, situated one above another, and separated by the grey substance, and also by the transverse fibrous layers which arise from the lateral prolongations of the cerebellum, pass through the annular protuberance.

They unite in front of this protuberance, and form the cerebral peduncle, of which the pyramids form the outer and lower side, and the two other cords the inner and upper side.

The formation of the cerebral peduncle by longitudinal layers, the edges of which converge from without inward, is more evident in the lower face than in the upper, the lower and convex face of which rests on the upper and concave face of the former. We may then oppose the upper and the lower parts to each other, and call the former the *base* and the latter the *cap* (*Haube*), of the cerebral peduncle.*

The three fasciculi produced by the division of each lateral anterior cord in the medulla oblongata, still continue separate in the cerebral peduncle and the cerebrum.

It is most convenient to describe the middle fasciculus first, because it terminates the soonest.

This fasciculus proceeds from within outward, and divides in the posterior part of the pons Variolii into two fasciculi: one proceeds below the black substance of the cerebral peduncle; the other, termed the *knot*,† goes upward, is seen externally between the anterior and middle prolongations of the cerebellum, and proceeding along the outer face of the former, goes obliquely to the posterior tubercula quadrigemina. It divides at the outside of the latter into two arms; one goes forward upon the external corpus geniculatum, and into the optic bed; the other proceeds transversely inward, disappears below the tubercula quadrigemina, forms the roof of the aqueduct of Sylvius, and blends forward with the posterior commissure, backward with the middle cord which goes from the posterior tubercula quadrigemina to the large cerebral valve.

The lower anterior fasciculi of the anterior cord of the spinal marrow, which correspond to the pyramids in the medulla oblongata, and

* Reil, *Archiv. für die Physiologie*, vol. ix. p. 150.
† Reil, *Archiv. für die Physiologie*, vol. ix. p. 505.

which are the direct continuation of them, form the lower part of the cerebral peduncle, and go from below upward and from within outward below the optici thalami.

The upper and posterior, which are larger, proceed directly towards the posterior part of the optic beds.

Both unite, leave the optic bed outward and the fibres of the layer forward, which proceed from within outward, and pass above them; at the anterior and external side of the protuberance, these cords and fibres interlace and give rise to a kind of suture, expanding in every direction. The external layers are reflected backward, and do not pass through the optic bed.

Hence it follows, that in each of the cerebral hemispheres there is a semicircle, the concavity of which is turned toward that of the opposite side, while it is convex externally, and which like the cerebral peduncle is composed of layers or rings which are directed from above downward. These rings expand in every direction like the sticks of a fan. Reil terms this the *corona radiata*. The posterior and middle rings, which are fewer, soon go outward and backward, and form most of the posterior and middle cerebral lobes. The anterior are more numerous, first pass through the corpus striatum, and then form the larger anterior lobe of the cerebrum.

The circumvolutions are formed of two strata of layers which are fitted to each other; they are united by serum effused in the ventricles, and may be more or less easily detached in the cadaver by compression, or by hardening the brain in different modes.

III. WEIGHT.

§ 1786. The cerebrum generally weighs three pounds, apothecaries' weight. Its proportoin then to the cerebellum is as 8 : 1, and to the medulla oblongata as 72 : 2.

IV. CONSISTENCE.

§ 1787. In regard to consistence, it differs only from the annular protuberance, which is much harder.

CHAPTER III.

ENVELOPS OF THE CENTRAL PART OF THE NERVOUS SYSTEM.

§ 1788. The central part of the nervous system is, as we have already stated, (§ 176) surrounded by several superimposed membranes. For a long time three have been admitted, an internal, the

pia-mater, a middle, the *arachnoid*, and an external, the *dura-mater*. But the ancient anatomists, and Lieutaud, Sabatier, and Chaussier among the moderns, considered the internal and middle as forming but one, called the *meningeal* (*meningina*), which is composed of two layers, distinct in the vertebral column, on the cerebellum and lower face of the cerebrum, but intimately blended in all other parts.

We must admit as correct, that the two inner membranes are very intimately connected in several parts, that they must be considered as forming only one: for we cannot demonstrate in the upper and lateral parts of the surface of the cerebrum, the two layers mentioned by Chaussier, and which he says are united by a very short cellular tissue. The pia-mater is alone visible in these parts.

In fact it is asserted that the arachnoid membrane extends like a bridge on the circumvolutions, while the pia-mater penetrates into these cavities, and that the former membrane may be easily separated by inflation: but we have always observed in repeating this and similar experiments, that the pia-mater was raised, and not a membrane distinct and separate from it.

It does not follow, however, that we must admit that the two inner meningeal membranes are the same. On the contrary, the following arguments exist against this opinion:—

1st. *Difference of structure.* The arachnoid membrane is whitish, semi-transparent, and destitute of vessels; the pia-mater is transparent and formed entirely of blood-vessels united by cellular tissue.

2nd. *Difference in the arrangement.* The two membranes are entirely distinct in several parts, and the arachnoid membrane is never found except on the surface, while the pia-mater penetrates deeply, and everywhere attends the surface of the cerebrum and spinal marrow.

3rd. *The structure of the fœtus.* In the cerebrum we can easily separate the arachnoid membrane from all the encephalon.

4th. *Difference of pathological changes.* The arachnoid membrane becomes harder and thicker: false membranes are formed by exudation from it. The pia-mater generally only receives more blood, and consequently assumes a redder tint. We must admit, however, that the pia-mater in several parts, particularly internally, sometimes experiences those changes regarded as belonging exclusively to the arachnoid membrane.

As the latter blends in a single membrane with the pia-mater within the skull, so too it unites with the dura-mater in the skull and vertebral canal so intimately, that it is very difficult and almost impossible to separate them.

ARTICLE FIRST.

OF THE PIA-MATER.

§ 1789. The *pia-mater* (*tunica ceribri vasculosa*, s. *propria*, s. *pia-mater*) is a thin membrane formed of a mucous tissue, in which the large vessels which go to, or return from, the central part of the nervous system expand. Its unattached upper face is smooth and moistened with serum. The internal, on the contrary, presents inequalities which arise from numerous villosities, greater or less branches of vessels, which attach it to the surface of the brain and spinal marrow. It not only lines the external face of the central portion of the nervous system, but also penetrates in several parts within it, where it conducts those vessels which carry the blood, and receives those which take it up again. We may then divide it into *internal* and *external*. These two sections of the membrane present considerable and constant differences in different regions of the central portion of the nervous system.

I. PIA-MATER OF THE SPINAL MARROW.

§ 1790. The *pia-mater of the spinal marrow* increases very much from above downward in thickness, hardness, and solidity. It exactly envelops the spinal cord in all its extent, so that when cut across, the medullary substance rises above the surface of the incision. Its colour is yellowish white. Its external face is smooth and entirely loose: it is in contact with the arachnoid membrane, from which it may be easily separated by blowing air between the two membranes.

At the lower extremity of the spinal marrow, the pia-mater becomes a simple filament, which descends between the nerves of the cauda equina to the lower extremity of the spinal dura-mater, with which it is blended at its termination.

Its internal part is formed by an anterior and a posterior prolongation, of which the former is larger and more apparent. These two prolongations extend from before backward and from behind forward, into the two middle fissures, and are arranged like the neurilemma as we have already remarked (§ 160).

II. PIA-MATER OF THE ENCEPHALON.

§ 1791. The *pia-mater of the encephalon* should necessarily be distinguished into *internal* and *external*, from the manifest differences in its form, presented within or on the outside of the organ.

a. EXTERNAL PIA-MATER.

§ 1792. The external pia-mater of the cerebrum, the cerebellum, and spinal marrow, is intimately adapted to the surface of these three sections of the central part of the nervous system, and penetrates into the greatest as well as in the smallest cavities to their bases, so that it represents exactly the external form of the parts. It does not leave the surface of the brain except in a few points. Thus in the *calamus scriptorius*, it passes from side to side, forming a transverse bridge sustained by a small medullary prominence, which is continuous forward at an acute angle with the pia-mater which covers the posterior face of the cerebellum. So too the thin layer which closes the third ventricle forward and downward before the decussation of the optic nerves, is often replaced by the pia-mater only, which extends like a bridge from one hemisphere to the other. These prolongations which penetrate into the superficial cavities, particularly into the grooves of the cerebellum and the anfractuosities of the cerebrum, are real folds,* since each is composed of two layers, which are united more intimately at the entrance of the anfractuosities than in their course and at their base, which must be attributed partly to the large vessels which pass in this place to the surface of the encephalon, so that they are easily insulated from each other when these vessels are destroyed.

The external pia-mater is continuous with the internal, wherever the external face of the encephalon is itself continuous with the internal, that is with that which forms the parietes of the ventricles. Thus these two membranes unite in the fourth ventricle, through the posterior cerebral fissure, and in the aqueduct of Sylvius, and also in the lateral ventricles by the anterior cerebral fissure.

We frequently observe on the external pia-mater, rounded and generally soft corpuscles, which are yellowish white, and collected in several masses; these are generally termed the *glands of Pacchioni* (*Gl. Pacchionianæ*)† but Bichat terms them the *cerebral granulations* (*granulationes cerebrales*). These corpuscles are situated principally along the centre of the superior longitudinal groove, especially at the orifice of the veins which enter into it. Placed on the external face of the pia-mater, they pass through the dura-mater, and even enter into the cavity of the sinus, where they are covered by the inner membrane of the venous system. They are generally arranged in several groups, but so that the different corpuscles of one must rest on a common base. They vary much in number and size; their structure is entirely homogeneous. As they are found particularly in the latter periods of life, as they never exist before, as they are not numerous

* Sœmmerring, *De cerebri administrationibus anatomicis, vasorumque, ejus habitu*; in *Munchner Denkschriften* for 1806 pp. 66, 67.

† Pacchioni, *Epist. phys. anat*; in *Opp. omn.*, Rome, 1741, p. 125.

except in persons often afflicted with diseases of the head, and as they are not observed particularly in any animal, we have reason to think them mere morbid formations resulting from the frequent rush of blood towards the brain.*

Still in no case do they deserve to be called glands. They have no excretory canals which carry a fluid secreted by them between the dura-mater and the pia-mater, or between thfs latter and the encephalon, or even within the cerebral ventricles, as Pacchioni asserts.

b. INTERNAL PIA-MATER.

§ 1793. The internal pia-mater differs from the external in its texture and form. In fact it is thinner and of a more delicate tissue. It adheres more intimately to the parts which it lines, and is, in fact, blended with them, as are the serous membranes with the articular cartilages upon which they pass. The portion which does not cover the surface of the ventricles, give rise to the *choroid plexuses* (*plexus choroidei*). These latter are composed essentially only of that portion of the internal pia-mater which is loose and entirely unattached in the ventricle. They form an immense number of folds which inter cross, and are arranged in several parallel longitudinal series. They are situated on the internal pia-mater, very near its union with the external, and on the edges of the fissures by which the external and the internal faces of the brain communicate. We find them in every section of the cerebral fissure, or of the cavity of the ventricle generally. Are not the folds there observed so many marks of the prolongations of the external pia-mater, which enter into the grooves of the external face, or rather do they not result from the collapse of the choroid plexuses after the early periods of life, when they are larger and are situated in the cavities of the encephalon, which are much more extensive?†

The branches of the veins from the inner face of the cerebral substance, unite in the choroid plexuses, and the arteries which penetrate into this same substance ramify in them.

* Wenzel, *loc. cit.* cap. i. *Corpuscula in exteriori meninge et infra eam abs utroque falcis latere.*—Portal (*Cours d'anat. med.* vol. ii.) has already doubted the glandular nature of these corpuscles, and maintained they were only cellular tissue filled with adipose substance (p. 10). In regard to similar bodies found in the choroid plexuses, he says, "(p. 44) as these glandular bodies appear only in disease, are they not concretions which are formed in the cellular tissue of the pia-mater, varying in size and hardness?"

† Desmoulins thinks (*Journal de physique*, Feb. 1821) the choroïd plexuses and telæ arise, from the fact that the internal pia-mater, after deposing concentric layers of white fibres, finally contracts. From this contraction or obliteration, result the concave internal surfaces of the folded membrane of the hemispheres, and the formation of the white and solid nucleus known as the oval centre. Tiedemann has already expressed, with slight modifications, the same opinion as Meckel. Desmoulins thinks that the membrane of the hemispheres gradually folds to produce the circumvolutions, and the pia-mater contracts proportionally in the cavity of the ventricles. He admits, consequently, the correctness of Gall's process for

We also find there some corpuscles corresponding to the glands of Pacchioni of the external pia-mater, in the same cases as the latter, and most generally at the same time as they.

Another very common pathological change of the choroid plexuses, is the occurrence of serous cysts, which are there accidentally developed.

I. CHOROID PLEXUS OF THE FOURTH VENTRICLE.

§ 1794. The *choroid plexus of the fourth ventricle* (*plexus choroideus ventriculi quarti*) begins on each side at the side and on the lower face of the root of the fourth lobe of the cerebellum, and is situated between it, the anterior edge of the monticule, the facial, the auditory, the glosso-pharyngeal, the pneumo-gastric, and the accessory nerves. Thence it goes transversely on the anterior part of the *calamus scriptorius* directly below the monticule, between it and the restiform body, and approaches that of the opposite side. The two plexuses united by a narrow band of the pia-mater then divide each into an anterior and a posterior branch. The posterior branches ascend in the posterior groove of the cerebellum, along the anterior part of the internal face of the monticule, become pointed, blend together, and terminate at the upper extremity of the uvula. The anterior, which are shorter, approach each other from before backward, and are blended together on the nodule of Malacarne.

This plexus receives from below upward the ramifications of the basilar and vertebral arteries and from above downward, and also on the sides those of the veins which arise from the inner face of the cerebellum.

The glands of Pacchioni are perhaps more common in this part than in the choroid plexuses of the cerebrum.

II. CHOROID PLEXUSES OF THE CEREBRUM.

§ 1795. The internal pia-mater of the cerebrum begins at the large cerebral fissure. It forms a layer which is much broader in the centre than on the sides, but more folded, on the contrary, on the sides than in the centre.

unfolding the brain, and thus explains the nature of what the latter terms the mucous neurilemma of agglutination of the internal surfaces, saying that it is the residuum of the pia-mater, which sometimes becoming permeable to the blood, can re-establish in greater or less portions, the primitive liberty of the internal surfaces. We only mention this assertion, without disputing it, as it seems easy to do with advantage. It is connected with another opinion of Desmoulins, that the development of the intellectual faculties is in direct ratio with that presented by the surface of the folded membrane of the hemispheres, consequently in a ratio with the number and depth of the circumvolutions. (*Sur le rapport le plus probable entre l'organization du cerveau et ses fonctions*, in the *Journ. compl., des de méd.* vol. xiii. p. 206). F. T.

It goes inward and forward from the posterior edge of the corpus callosum, the internal face of the posterior lobes, the cerebral peduncles, the tubercula quadrigemina, and from the middle anterior portion of the cerebellum, is continuous on one side with the external pia-mater which covers these parts, and envelops on the other the pineal gland, and proceeds forward and inward under the posterior edge of the corpus callosum and of the fornix. It thus forms a triangular layer, the base of which looks backward and the summit forward. The internal face of this layer is united by its lower part with the upper face of the optic bed, and by its upper with the lower face of the fornix. Hence these faces are connected so intimately, except at the lower part, for the space of about two lines deep and one high, that the third ventricle is perfectly closed at its upper part, and is separated outward from the two lateral ventricles.

This portion of the internal pia-mater may be termed the *choroid web* (*tela choroidea*, Vicq-d'Azyr.)

It is continuous outward and backward with the choroid plexuses of the ventricles.

These plexuses which arise from the opening through which the two lateral ventricles communicate, proceed from behind forward and from within outward on the lower face of the centre of each ventricle, and afterward descend from behind forward in the lateral horn, on the corpus fimbriatum and the cornu Ammonis. A slight fold attaches them in all their course to the lateral edges and the anterior edge of the fornix, and the corpus fimbriatum which is detached from it. Their form then exactly represents that of the descending horn, into which they penetrate to its anterior extremity, and the lower face of which they cover in great part. At their anterior extremity, that is, at their origin, in the communication open between the two lateral ventricles they are very narrow, but they gradually enlarge from before backward, and finally become considerably broad.

Their breadth, however, does not increase from their origin to the lower extremity of the lateral horn. Their broadest and thickest part corresponds to about their centre, that is, where instead of internal they become external. There, in fact, they form a kind of button, which has been remarked by Vicq-d'Azyr,* and has been admitted by Wenzel.† The vessels, particularly the veins, are there much larger and also more tortuous than in the rest of the plexus: the internal pia-mater which unites them also forms there more numerous folds.

* *Loc. cit.* p. 541. "The region in which the plexus is thickest, is that where it curves backward, at the level of the posterior prolongations of the lateral ventricles." Vicq-d'Azyr has also described the structure of the choroid plexus, and this figure of it resembles that given by Wenzel.

† *Loc. cit.* n. x. *Animadv. peculiarem quand. proprietatem plexus choroidei, etc. Proprietas quædam ratione morborum, ut nobis videtur, notatu digna ab auctoribus prætervisa.*

The choroid plexus also, when otherwise perfectly healthy, is rather more disposed in this place to morbid changes, such as thickening, opacity, and more or less abundant granulations which vary in form and size, and which probably arise, at least in part, in the folds of the plexus, but which are also developed on the surface of these folds.*

The greater development of the choroid plexus in this place depends particularly, and even solely, on the origin at that part of the posterior horn, which receives no special choroid plexus.

Besides this common choroid plexus, we sometimes find in the lateral ventricles a smaller and anterior plexus, which is situated on the corpora striata. This communicates with the veins which proceed between the anterior and posterior cerebral ganglions, and with those which arise from these eminences.†

On the contrary, we constantly find two small choroid plexuses, those of the third ventricle, which extend from before backward, from the anterior extremity of the lateral choroid flexus to the circumference of the pineal gland, separate from each other in this course, are attached to the lower face of the tela choroidea, gradually increase in size and receive the vessels of the third and fourth ventricle.

All the sections of the general ventricle of the encephalon include then the choroid plexuses which communicate by the internal pia-mater and the cerebral vessels, and which are most generally found more or less precisely in the same state in the same subject.

ARTICLE SECOND.

OF THE ARACHNOID MEMBRANE.

§ 1796. The *arachnoid membrane* (*mem. arachnoidea*, s. *mucosa*), the second envelop of the spinal marrow and encephalon, is delicate, thin, semi-transparent, whitish, and perfectly homogenous in structure. We have not as yet been able to discover in it either vessels or nerves.

It is very distant from the preceding in the vertebral column and in the lower part of the skull.

It surrounds the spinal marrow, like a sac which is much larger than this cord, which is attached to it only by some distinct filaments of cellular tissue. It begins at the lower extremity of the vertebral column, and gives a general envelop, which covers the origin of all the nerves in the spinal canal until they leave this cavity. We may then separate it very much from the spinal marrow by blowing in air, or by any analogous process.

It is also intimately united with the dura-mater in the place

* Vicq-d'Azyr has also made this remark: he expresses himself very strongly against the glandular nature of this body.

† Vicq-d'Azyr, p. 540.

where this membrane forms narrow canals which receive the nerves before they leave the vertebral canal, and where the slips of the ligamentum dentatum are attached to its surface.

It proceeds from the spinal marrow to the encephalon, enlarging very much. It adheres to the lower and middle portions of the cerebrum, and also to the posterior part of the cerebellum and to the lower face of the medulla oblongata very loosely, and by long distinct bands of cellular substance, passes like a bridge from the spinal marrow to the posterior part of the cerebellum, and from one lobe of the latter organ to another, consequently fills the space between them, closes the common cerebral fissure posteriorly, below and on the sides, is reflected from the annular protuberance on the floor of the third ventricle towards the decussation of the optic nerves, with which it is intimately united, as also with the nerve itself; then arrives at the lower face of the anterior lobes, and connects both these two lobes and also the central part of the posterior, on which it extends on each side on leaving the annular protuberance. It also forms a bridge which proceeds on the fissure of Sylvius, between the posterior and anterior lobes.

All the veins and nerves which come from the encephalon, and also the arteries which go to it, are covered by prolongations of the arachnoid membrane until they emerge from, or enter the cranium.

But the places we have mentioned are the only ones where it is so slightly attached to the subjacent pia-mater that it may be considered a separate and distinct membrane. In every other part, even where it passes from one circumvolution to another, proceeding over the anfractuosities, it is so intimately united with the pia-mater that, however carefully we may attempt to raise it, particularly by the common mode, that of insufflation, this membrane is always detached with it from the surface of the cerebrum.

§ 1797. From the idea generally formed of it, the arachnoid membrane forms only a single layer, which covers the outer face of the spinal marrow and encephalon; but it rarely extends farther, and has a more complex course. In fact, it is reflected from all the places through which the nerves and vessels pass upon the dura-mater, the internal face of which it covers, and also penetrates within the encephalon through the large cerebral fissure.

The first proposition is perfectly demonstrated either by dissecting the arachnoid membrane and the dura-mater in the normal and abnormal state, or by analogy. The brilliant and smooth appearance of the inner face of the dura-mater favours it, since the parietes of the pectoral cavity, the abdominal cavity, and the pericardium, depend for this character on the presence of serous membranes, which after directly covering the surfaces of the organs, leave them to be reflected externally. This external layer of the arachnoid membrane is fitted to the inner face of a fibrous membrane like the serous tunic of the pericardium, the peritoneum and the two pleuræ in many places, the

synovial membranes, &c. That the shining appearance of the inner face of the dura-mater does not depend on this membrane is proved by the fact that the interior of the canals it furnishes to the nerves out of the arachnoid sac is very uneven.

When we examine the dura-mater either from without inward or from within outward, although the external layers seem formed of fibres and of a very complex texture, we may always detach to a greater or less extent an internal layer, which is thinner than the others, and has not a fibrous appearance: this may be easily proved in the early periods of life. This internal layer is sometimes separated from the others by a congestion of pus between it and the dura-mater it lines.*

The arachnoid membrane not only covers the surface of the cerebrum, but also penetrates within this organ. The place where it enters is between the anterior extremity of the upper face of the cerebellum and the corpus callosum, in the place where the portion of this membrane which covers the cerebrum unites to that of the cerebellum, without forming however a smple sac. The connection seems on the contrary to be interrupted by a rounded opening in this place, in the circumference of which the glands of Pacchioni are generally situated in old persons, and which give passage to the veins which arise from the ventricles of the cerebrum: but this opening is the commencement of the inner part of the arachnoid membrane, for it leads to a canal which passes on the pineal gland and extends from behind forward on and between the anterior edges of the optic beds, and below the fornix to the anterior extremity of the third ventricle. This canal surrounds the venous trunks which return from the middle and lateral ventricles. It is every where perforated for the branches which go to it. Its external face is connected with the adjacent parts of the cerebrum only by slight adhesions, and is also attached to the veins by distinct filaments. It terminates at the foramen of Monro. Thence it continues, uniting intimately to the pia-mater, with the internal membrane of the ventricles, which in the normal state is much thinner than it, but which in the pathological state, in inflammation and hydrocephalus, thickens, becomes opaque, whitish, so that then it is still nearer to it and to the outer part of the arachnoide membrane.

The arachnoid membrane most resembles the serous membranes in its form, texture, secretions, its anatomical relations with the encephalon and spinal marrow and with the dura-mater, and in its diseases, as thickening, increase of its secretory power, whence result congestions of serum, adhesions between contiguous surfaces or the formation of accidental membranes. It is almost exactly like them. Gordon then is wrong in supposing that the analogy between its texture and that of the serous membranes is not proved, and that we must consider it as a separate organic tissue different from all others.

* Vicq-d'Azyr, in the *Mém. de Paris*, 1781, p. 497.

All the facts we have adduced authorise us to arrange the arachnoid membrane and the dura-mater in the class of sero-fibrous membranes. It however is important to remark, that these two membranes are very intimately united with each other, and that the difference observed between them in the adult does not exist in the fœtus, where we find, instead of the dura-mater, only a single thin transparent membrane destitute of fibres, and having all the characters of a serous membrane. But there we evidently have a new fact in support of our opinion in regard to the nature of the arachnoid membrane. At first only the inner layer of the dura-mater is formed; afterward it is changed externally into a fibrous tissue, or this tissue is developed between it and the bones.

ARTICLE THIRD.

OF THE DURA-MATER.

§ 1798. The *dura-mater* (*dura-meninx*), a fibrous membrane, is the most external envelop of the spinal marrow and encephalon. It forms a sac closed in every part, which has the form of these two organs. Its external face looks to the inner face of the spinal canal and the skull; the internal is turned towards the outer face of the arachnoid membrane. This latter is smooth in every part.

The vessels of the spinal portion of the dura-mater arise from the vertebral, the intercostal, the lumbar, and the sacral arteries: those of the cranial portion from the internal maxillary artery.

I. SPINAL DURA-MATER.

§ 1799. The spinal portion of the dura-mater differs in several respects from the cephalic. It forms a very long canal, terminated at its lower part in a cul-de-sac, which occupies the whole spinal canal, gradually enlarges from above downward, but terminates in a blunt summit at the lower extremity of the sacrum. This sac is narrower than the spinal canal, to which it adheres, principally on the sides and posteriorly, only by a very loose cellular tissue, which contains, especially at its lower part, an abundance of substance similar to fat of a reddish yellow colour. It is united anteriorly to the posterior ligamentous envelop of the vertebral column much more intimately.

The two faces of the spinal dura-mater are smooth. It is not only longer, but much broader than the spinal marrow. Outwardly it gives to each spinal nerve a sheath which accompanies it to beyond the intervertebral foramen, enlarges a little in this place on account

of the ganglion of the posterior root, and gradually terminates in the external cellular tunic of the nerve.

It is very evidently formed of longitudinal fibres which are more regular and less distinct than those of the cranial portion, and it is thinner than the cerebral dura-mater.

II. CEREBRAL DURA-MATER.

§ 1800. The portion of the dura-mater which corresponds to the encephalon, is attached to the internal face of the skull by numerous small ramifications of vessels which extend from it to the bones: its external face is corrugated. It adheres very strongly to the skull at its lower part: its lateral and upper faces are connected with the sutures more intimately than with the other parts of the cranium.

The arteries and veins proceed on its external face in the slight depressions which they exactly fill, and also project above its surface.

There are but few fibres visible on its external face. The centre of its upper part presents some which are irregular, flat, have a transverse direction, and intercross.

We distinguish through the dura-mater the vessels of the pia-mater, and also the elevations and depressions of the external face of the encephalon.

The inner part of its upper face presents at intervals along the large longitudinal sinus, and some lines from this venous canal, some broad and some narrow openings, which are seen principally in the region of the sinciput.

Internally it presents in all its extent a fibrous texture much more distinct than that of the spinal portion. We may divide the fibres seen there into two layers. The external follow a longitudinal direction for all the extent of the membrane, and are arranged very compactly; the internal are placed on the preceding, to which they generally adhere but slightly, and are much more separated from each other; they are particularly apparent and very numerous at the upper part, while they gradually disappear at the lower.

Although the dura-mater is usually considered as divided into several layers, between which the venous sinuses proceed, and is composed of two folds, and although we can in fact divide it into two layers, still this separation is purely artificial, always excepting the serous layer; we can never form them except by destroying the tissue, and we may at pleasure diminish or increase the number of the layers.

The cerebral dura-mater principally differs in its arrangement from the spinal by the following characters:—

1st. It does not form a single sac but a cavity which is divided into several partitions by different prolongations which it sends inward. These prolongations are in direct ratio with the development of the encephalon, as they divide the cavity of the skull into compartments destined to receive the principal portions of this organ.

We number three of them, a transverse and two longitudinal. They have this in common, that at their external edge, which is connected with the internal face of the skull, they divide into three layers, the external of which continues to follow the direction of the common sac of the dura-mater, while the two internal converge inward and are soon blended in a single layer which terminates in a loose internal edge. Besides the external edges, the internal edges, and the faces of the prolongations, are continuous with each other, and they may be described under the common name of the *crucial prolongation of the dura-mater* (*processus duræ matris cruciatus*), the branches of which extend to the right and left, upward and downward, and forward and backward.

The transverse prolongation is the *tentorium of the cerebellum*, the *transverse septum* (*tentorium cerebelli*). Its form is nearly semicircular. Its posterior, convex, and internal edge, which is the longest, arises from the transverse branches of the cruciform ridge of the occipital bone, and from the upper edge of the petrous portion of the temporal bone. The anterior, which is much smaller and concave, is loose: it forms the posterior and lateral parts of an opening which is closed anteriorly by the basilar portion of the spheno-occipital bone, and is attached on each side by two separate points to the anterior and posterior clinoid processes, between which it covers on both sides the sella turcica.

The cerebellum and the medulla oblongata are situated under this tentorium, which completely separates from the rest of the skull, excepting only from the anterior opening, the posterior and inferior part destined to receive it.

The central portion of the tentorium is continuous upward and downward with the two longitudinal prolongations, the falx of the cerebrum, and the falx of the cerebellum, both of which are situated on the median line, and the external edge of which is convex and broader than the other, and is attached from before backward to the external edge of the dura-mater, while the internal is concave, sharp, and loose. These prolongations separate the right and left portions of the cerebrum and cerebellum.

The *falx of the cerebellum*, the *median septum of the cerebellum* (*falx cerebelli*), is situated posteriorly between the two hemispheres of the cerebellum, extends from the centre of the posterior edge of the tentorium of which it makes a part, and from the inner occipital protuberance to the centre of the posterior edge of the large occipital foramen. It descends along the internal occipital crest, gradually contracts and divides at its lower extremity into two small lateral folds which extend forward.

The *falx of the cerebrum*, or the *large falx*, the *longitudinal fold of the meninx*, (*falx cerebri*, s. *processus falciformis cerebri*, s. *major*) arises from the centre of the upper face of the dura-mater, under the form of a prolongation which descends vertically between the two hemispheres of the cerebrum in all their length. It gradually increases in height

from before backward. Posteriorly it rests by its lower edge on the tentorium, of which it forms a part, and its anterior portion which is much more extensive, terminates in a loose and concave edge. It advances above the centre of the corpus callosum, but does not touch it except at its posterior extremity, for the arteries of the corpus callosum are at least one line distant from it.

The large falx is attached by its external edge forward to the internal frontal crest, and in the rest of its extent to the inside of the saggital suture. The upper longitudinal sinus is situated between the two layers which form its external edge superiorly. It is also divided at its concave edge into two layers, which receive between them the inferior longitudinal sinus and the right sinus. The posterior part of its inferior edge is continuous on each side with the tentorium.

This prolongation is smooth on its two faces. It has manifestly a fibrous structure.

Most of the fibres which form it are oblique from behind forward and from below upward. They are more horizontal the more anterior they become. Others, which are much fewer, and which cross the preceding, are observed particularly at the anterior part and at the upper edge of the falx, so that we cannot there mistake the analogy between the dorsal and ventral faces any more than the distinctive character of these two faces, which is that the first is stronger than the second.

The falx presents not very unfrequently, especially near its lower edge, considerable spaces, openings through which the internal walls of the two cerebral hemispheres touch and sometimes even adhere together.

2d. The cerebral dura-mater has not the same relation as the spinal in regard to the nerves which emerge from the skull; it generally accompanies them farther than this latter and follows the spinal nerves, so that for instance, the commencement of the three branches of the trifacial nerve is enclosed in special canals. The envelop it gives unites them still more closely, and when they emerge from the skull it is continuous with the periosteum of the bones, while the spinal dura-mater terminates only in the cellular sheath of the nerves.

III. LIGAMENTUM DENTICULATUM.

§ 1801. The spinal marrow has one mode of attachment which the cerebrum has not, and which very probably serves to compensate for the liberty which it enjoys in the vertebral canal, on account of the disproportion between its volume and the calibre of this canal. We mean the *ligamentum denticulatum*, or *serratum*.

This ligament descends on both sides between the anterior and the posterior series of the roots of the spinal nerves, commences directly above the occipital foramen and terminates some distance above the extremity of the spinal marrow, at the summit of its

inferior expansion. It is situated above the vertebral artery when it enters the skull, and before the accessory nerve: in the rest of its course it is nearer the anterior than the posterior roots. It is smooth, thin, narrow, whitish, and composed of a series of triangular slips united at their base by a very thin band. The base of these slips is thin and flat, and rests directly on the pia-mater. Their summits are rounded, harder, thicker, and turned downward, and are attached to the arachnoid membrane and still more firmly to the dura-mater. There is generally one between each pair of cervical and dorsal nerves, and they are usually nearer the lower than the upper nerve. Hence, in most subjects, there are twenty of them. Their number, however, is by no means constant: they are frequently fewer than the nerves, because one slip between one or several pairs of nerves is generally deficient, although there is nothing determinate in this respect. More rarely two are found between two pairs of nerves. Their whole number then varies from twelve or fourteen* to twenty-two or twenty-three.†

The ligamentum denticulatum enlarges from above downward, and the slips separate still more from each other the lower they are. Below these latter we observe a fold about an inch in length which proceeds along the sides of the spinal marrow, but rarely or even never descends to the real termination of this cord. Not unfrequently also the ligamentum denticulatum is perforated, especially at its upper part, whence it has a reticulated appearance.‡

Judging from its texture, this ligament seems to belong to the class of fibrous organs, since not only the slips but also the external part of the membrane extended between them have a silvery lustre, and longitudinal fibres are very evident internally. It also adheres very intimately to the spinal dura-mater, while it is attached to the pia-mater only by a cellular tissue, which is in fact solid, but is easily torn. We cannot then consider it as a prolongation of the pia-mater as do many anatomists, whose opinion Bichat has justly opposed,§ and it is more proper to regard it as an internal prolongation of the dura-mater, since the cerebral portion of this membrane sends those prolongations which are so remarkable between the different regions of the mass of the encephalon.

* Sabatier, *loc. cit.*, p. 460.
† Gordon, *loc. cit.*, p. 190.
‡ Vicq-d'Ayzr, *loc. cit.*, p. 603.
§ *Anat. génér.*

CHAPTER IV.

PERIODICAL DIFFERENCES OF THE CENTRAL PORTION OF THE NERVOUS SYSTEM DURING ITS DEVELOPMENT.

§ 1802. The development of the central part of the nervous system * has been studied but a few years; hitherto only the general traits of this history, its most prominent features, have attracted attention.

I. SUBSTANCE.

§ 1803. The principal differences in the substance of the central part of the nervous system relate to the extent, form, situation, texture, colour, and relations with the envelops.

1st. *Extent.* The central part of the nervous system is generally much larger in proportion to the body the younger the organism is. The spinal marrow occupies all the length of the vertebral canal until the end of the third month of pregnancy. It is true that from this period it begins to shorten, but it is not confined to its normal limits till the eighth month of pregnancy. It is also thicker during the early periods of life.

The encephalon, with the exception of the cerebellum, is also proportionally much more extensive. It must not however be thought, especially in regard to this viscus, that a greater extent is perfectly synonymous with a greater mass, for the parietes are proportionally much thinner than at a more advanced age.

The encephalon until perfectly developed, continues to be larger in proportion to the body than it is finally: for between six and seven years, according to Wenzel,† and Sœmmerring ‡ states even from the third year, it has acquired the size and weight which it will retain through life.

2nd. *Situation.* The very imperfect development of the posterior part of the vertebral column causes the spinal marrow and the encephalon to be much looser and less attached during the early periods of existence.

* Tiedemann, *Anatomie du cerveau, contenant l'histoire de son développement dans le fœtus*, trans. by Jourdan, Paris, 1823.—Schoenlein, *Von der Hirnmetamorphose*, Wurzburgh, 1816.--Serres, *Anatomie comparée du cerveau dans les quatre classes de vertébrés*, Paris, 1824.—Desmoulins, *Exposition succincte du développement et des fonctions du systéme cérébro spinal*; in the *Archives généralés de médecine*, juin 1823.—Rolando, in several articles of the *Dizzionario periodico di medicina*, Turin, 1822 et suiv.

† *De penitiori struct. cereb.*, p. 266.

‡ *Tab. baseos encephali*, p. 13.

3d. *Form.* The differences in respect to the form are very remarkable.

I. SPINAL MARROW.

a. The calibre of the spinal marrow is much more uniform the younger the fœtus is. The prominences which correspond to the nerves of the extremities develop themselves only in proportion as the extremities appear.

b. The spinal marrow which is entirely full and solid, not only in full grown subjects but already even during the early months of existence, encloses at first in all its length a canal which is uninterruptedly continuous with the cerebral fissure, and which is larger in those parts where the spinal canal is prominent.

This canal is at first not rounded, but oblong from before backward, and if we except a small plate which bounds it anteriorly, it extends through the whole thickness of the spinal marrow. Hence the internal face of the latter is at first continuous with the external, as the whole canal is much larger during the early periods of life than at a more advanced epoch, and then it does not resemble a proper canal so much as a fissure, which separates almost entirely the two lateral portions of the spinal cord. This canal also gradually closes and contracts from without inward at the posterior part: the spinal marrow then folds longitudinally forward and backward: hence arise anterior and posterior longitudinal grooves, which never communicate with the central canal, even as the cerebrum and the summit of the spinal cord, present during life not only two longitudinal grooves, an upper and a lower, but also two central cavities separated from these same grooves by medullary substance in at least most of their extent, and by the pia-mater in all their course. The longitudinal grooves of the pia-mater, however, are broader during the early periods of existence, and the posterior not unfrequently entirely disappear as the subject grows older.

c. Although the spinal prolongation is at first much larger in proportion to the whole body than it is in the adult, we soon see an opposite relation between it and the encephalon, both from the development of the latter, and from the diminution of the spinial cord.

Thus we have found that the proportion between the spinal marrow and the cerebrum was still as 1 : 107, and even as 1 : 112, in the full grown fœtus and the child of five months: for the cerebrum of the fœtus weighs nine ounces and four drachms, and that of the child five months old, twenty-one ounces, the spinal marrow of the former two scruples and five grains, and that of the second a drachm and a half. In a fœtus of five months, on the contrary, the proportion was as 1 : 63, since the cerebrum weighed six drachms, one scruple, and eight grains, and the spinal marrow six grains. It was as 1 : 18 in a fœtus of three months, where the brain weighed thirty-

six grains and the spinal marrow two. In the adult it is as 1 : 40. These estimates will serve to rectify the calculations given by some anatomists, of the differences observed at different periods of life, in the respective proportion of the encephalon and the spinal cord.*

The younger the fœtus, the larger the spinal marrow in proportion to the encephalon. It is evidently larger and heavier in proportion to this latter, even in the human fœtus of three months, than in the adult, either on account of its greater size, or of the smallness of the encephalon; but the latter soon exceeds it more than in the adult, both because it increases much, and because the spinal cord itself diminishes.

II. MEDULLA OBLONGATA.

a. The medulla oblongata, except perhaps in the earliest periods of its formation, is much more distinct from the spinal marrow, and the angle between the two organs is much nearer a right angle, the younger the fœtus is.

b. It is also proportionally much more developed during the early periods of life than at a more advanced age. This proposition is applicable particularly to its lower and anterior part, which concurs to form the cerebrum. Hence, why the medulla oblongata is still more distinct from the spinal marrow in the full grown fœtus and the young child than in the adult, and why, also, all its parts, particularly the eminences of its lower face, the pyramids and olivary bodies, are then more permanent, and separated by more distinct limits. This circumstance seems to be in direct ratio with the greater development of the cerebrum.

c. The *calamus scriptorius* is much larger in the early periods of existence, because its parietes are then thinner, and the distance between them from behind forward is greater. The transverse cord

* Carus (*Anatomie und Physiologie der Nervensystems*, p. 262) expresses himself upon this subject very vaguely, for he merely states that the proportional volume of the spinal marrow and cerebrum, is that which varies the least in the human fœtus and the adult, both because the disproportion between the encephalon and the spinal marrow seems less from the great volume of this latter, and because the type of the human species always predominates even here. He, however, admits farther on (p. 266), that the spinal marrow is always larger, compared with the encephalon in the human fœtus than in the adult, although it is not much larger than when the subject is fully developed. Tiedemann (*loc. cit.*, p. 141, 142, 143) makes a more exact statement: he says that the volume of the spinal marrow is much larger compared to that of the brain the younger the fœtus is; that the human fœtus perfectly corresponds to animals in this respect, and that the cerebrum becomes much larger in proportion to the spinal marrow the nearer it is to its period of perfect development. From what we have said above, it follows that this proposition is true, at most only for the early periods of fœtal life; that an inverse proportion soon supervenes, and that consequently, we observe, before that which marks the perfect state, another, where the encephalon presents, in proportion to the spinal marrow, a much greater volume than it has in the adult, so that regarding only the mass and weight, we find at this period a relation more favourable to the cerebrum than that observed in full grown subjects.

which closes it superiorly, does not exist at first, but it is greater during the early periods of fœtal existence than in the adult.

The white striæ upon the floor of the *calamus scriptorius*, do not appear till some months after birth, while the grey eminences before them are visible in the fœtus of three months.*

d. The olivary bodies appear in the third month of fœtal existence,† but when the fœtus is full grown, they are formed externally only of grey substance. In the third, and even in the fifth month of pregnancy, we discover within them a small cavity, which disappears entirely at the sixth.‡ When they have become completely solid, the grey substance ramifies there at first more simply than it does afterward.§

e. The pyramids appear much sooner than the olivary bodies, and are also, proportionally speaking, much larger at first than in the adult.

f. The corpus callosum does not appear till late and till the third month. It is at first thinner and shorter. Its size in proportion to that of the medulla oblongata is still less. The longitudinal groove of the lower face is deeper in the full grown fœtus than in the adult.

III. CEREBELLUM.

The cerebellum is one of the parts of the central mass of the nervous system which are developed the latest.

It appears during the sixth week of fœtal existence as a very small layer, at first hardly visible, thin, horizontal, situated transversely on and before the *calamus scriptorius*, divided by a deep median fissure into two halves, which is only a slight appendage of the tubercula quadrigemina, with which it is continuous upward and forward at an obtuse angle. The transition is made afterward less insensibly, because the anterior valve is developed between the two organs. Very probably, the part of the cerebellum which exists first, is only the vulvule of Vieussens, which opinion is supported by this thinness, and the fact that the cerebrum, generally considered, is formed from below upward. This primitive layer gradually becomes thicker from above downward, and finally gives rise to the cerebellum: but it is very low in regard to its other two dimensions, and is very small in proportion to the otner parts of the encephalon.

In the full grown fœtus, the relation of the cerebellum to the cerebrum, is still generally as 1 : 23, since the cerebrum weighs between nine and ten ounces, and the cerebellum about three and a half drachms. The cerebellum, however, rapidly attains its normal proportional size.

* Wenzel, *De pen. struct. cereb.*, p. 320, 321.
† Carus, *loc. cit.*, p. 289.—Tiedemann asserts that they are not developed till the end of the fifth or the beginning of the seventh month.
‡ Carus, *loc. cit.*, p. 289.
§ Carus, *loc. cit.*, p. 290.

We have determined that the relation one month after birth is as 1 : 17, and five or six months later is as 1 : 8, at which period the cerebrum weighs about sixteen ounces, and the cerebellum two.

The component parts of the cerebellum, however, are developed earlier than those of the cerebrum. We observe grooves on its surface about the end of the fourth month of pregnancy: they appear first at its central part. The largest also, those which divide the organs into lobes, appear before the small, and the latter are at first much more superficial and more simple than at subsequent periods.

The rhomboid body of the cerebellum includes at first a cavity, which still appears at the third month.*

IV. CEREBRUM.

If we except the early periods when the spinal marrow and medulla oblongata predominate so manifestly, the cerebrum is at first much larger and heavier in proportion to all the other parts of the centre of the nervous system than in the adult.

The great differences in its structure, oblige us to consider its parts in the same order as when we described them.

a. Cerebral prolongations. The most remarkable thing in regard to the cerebral peduncles, is the direction they assume at first: their posterior part rises perpendicularly, and is continuous at an acute angle with the anterior, which also descends as vertically as the other, and directly before it.

They are besides much larger in the fœtus than in the adult, in proportion to the other parts of the cerebrum.

b. Tubercula quadrigemina. These tubercles, with the cerebral peduncles, are at first the largest part of the cerebrum. They are then much larger in proportion to the volume they have afterward, than one of the central portions, and form the highest part of the cerebrum, so that they have sometimes been mistaken for the cerebellum.†

They do not at first deserve the name which is generally given to them, for they are separated neither lengthwise nor breadthwise, but form a very elongated homogeneous mass. Their lateral halves are probably not united at first on the median line by nervous substance, and the communication between them is established only by the pia-mater.

Their longitudinal groove appears a little before the transverse. It is developed from before backward, so that it separates the two anterior eminences sooner than the two posterior. The transverse groove is situated at first, proportionally speaking, farther back, whence the anterior pair of eminences is always much larger proportionally at first than in the adult.

* Carus, *loc. cit.*, p. 285.

† Harvey, *De generat.*, Amsterdam, 1662, p. 301.—Autenreith, *Suppl. ad hist. emb.*, p. 21.

The tubercula quadrigemina are still larger in proportion to their breadth, in the fœtus than in the adult. Although in the latter they are more long than broad, they however possess their normal length at the period of birth, and after this time they only increase more or less in breadth.

Their parieties are much thinner if examined at a period still nearer conception. They also enclose a considerable cavity which gradually becomes smaller as their parietes thicken, and which is united by the small grooves within them.

c. *Pineal gland.* It would seem as if this body did not begin to appear till the third or fourth month of pregnancy.* It is at first more rounded and flat. We find no trace of concretions until the period of birth, but sooner or later, sometimes not till the seventh year, a soft and viscous substance forms before it, which is situated on the posterior commissure, and gradually hardens after the age of seven years, and begins by surrounding it. Sometimes, however, we find no trace of pineal concretions in much older subjects, a rare peculiarity which is established by the observations of Wenzel and ourselves. The number of these concretions generally increases in age. In youth, the viscous substance and the concretions are situated before the pineal gland: in the adult we find them also in the anterior depression and in the substance of the gland: in old subjects they exist in all these places at once. These concretions are paler in infancy and in old age, than in the intermediate periods.†

d. *Optic beds.* These eminences are larger in the fœtus than in the adult, in proportion to the corpora striata and the hemispheres.

At first they are entirely separated from each other. Afterward, but always at an early period of conception, they adhere on the limits of their upper and internal faces, by a thin but very distinct medullary layer, which extends between them like a bridge. Much later, and about the fourth month, the commissura mollis is formed, but it is at first much larger than in the adult, which character it still preserves in the full-grown fœtus, and even in infancy. The upper bridge has long disappeared at birth.

e. *Corpora striata.* These bodies appear later than the optic beds. They are at first smaller in proportion to the latter and the hemispheres, and are developed in the form of prominences of the inferior wall of these latter; they are never hollow internally, and are much more distinct from the hemispheres and the optic beds as the fœtus is younger.

f. Hemispheres. We have always found the hemispheres of the cerebrum before the corpora striata. They are much larger and more extensive in proportion to these latter, the younger the fœtus is. At first, however, they are extremely small in proportion to the other parts before which they are situated, but do not extend beyond them

* Tiedemann, *loc. cit.*, p. 216.
† Wenzel, *loc. cit.*, p. 315.

on the side. At first they are very rounded, and then become more oblong than they are when fully developed. We are not yet certain whether they are separated from each other at the period of their formation, or if they form only one rounded transverse prominence. Observations upon the fœtuses of sheep, analogy with the development of other parts, the tubercula quadrigemina for instance, and the manner in which they are developed in the animal series, render the second hypothesis probable.* This period, however, if it occurs, (of which we have not the least doubt, from researches made recently upon very young fœtuses of sheep,) passes very quickly, and is replaced by another, which presents an arrangement opposite to that we have mentioned. The two hemispheres separate from each other completely; their internal parieties are perfect except a small space at their posterior part, and their internal faces are, it is true, placed one against the other; but we can separate them entirely without the least laceration, as in the cerebral hemispheres of birds.

The hemispheres continue to increase and gradually extend outward, backward, and upward, so that they cover first the optic beds, then also the tubercula quadrigemina, and finally the cerebellum.

Their surface continues smooth for a long time, and we observe there no trace either of the division into lobes, or of circumvolutions and anfractuosities. Their parieties are at first exceedingly thin in proportion to the space they circumscribe.

The fissure of Sylvius is developed at the third month, under the form of an oblique fissure, between the anterior lobe and the middle lobe; but it continues for a long time more superficial than in the adult, and forms at first only a slight depression, which depends particularly on the fact that the middle lobe is then proportionally much shorter, and only increases gradually from above downward. Hence, why the isle of the fissure of Sylvius is at first entirely loose and unattached. The circumvolutions and the anfractuosities appear afterward, not until the fourth and fifth month, and the internal of the upper face appear before all the others. The prominences of the isle of the fissure of Sylvius form last, and we have found no trace of them in the fœtus of eight months.

g. Those parts of the cerebrum which serve to unite the others, the corpus callosum and the fornix, are developed the last. At first we find in their place only a fold of the internal wall of the hemispheres, which is entirely hollowed outward, and which projects within the cerebral cavity. This fold gradually disappears in its anterior part, and as it vanishes, the corpus callosum forms from before backward, so that this latter seems to depend on the circumstance that the cerebral substance turned at first outward, is reflected inward, and the internal walls of the two hemispheres then unite in this latter direction.

But below this point the internal parietes separate still more, and

* Meckel, *Deutsches Archiv. fur die Physiologie*, vol. i. p.385.

thus form the ventricle of the septum, which finally contracts considerably.

The *fornix* and the *corpus fimbriatum* arise from the enlargement of a small cavity in the hemisphere through which the pia-mater penetrates from before backward, to produce the large cerebral fissure which increases its distance from the optic bed.

The *mammillary eminences* form until the seventh month a single eminence, which perhaps develops itself in the same proportion as the internal wall of the lateral ventricles is separated by the pia-mater which penetrates within it.

The *anterior commissure* appears at three months.

The *ventricles of the cerebrum* present several remarkable differences at different periods of development.

It is a general law, that they are larger in proportion to their parietes, the younger the organism is. This circumstance depends principally on the thinness of their parietes, as we have already stated when speaking of the tubercula quadrigemina, the optic beds, the cerebral hemispheres, and the medulla oblongata. The fossa of the medulla oblongata is also much larger in the early periods from the great development of this part.

The form of the hemispheres also varies at different periods of life.

In the early stages of pregnancy, the hemispheres form in fact only one large cavity, since there is then no ventricle of the septum nor corpus callosum, the space between the internal walls of the hemispheres is in no manner closed.

At a later period the ventricle of the septum, which when the subject is perfectly developed is generally entirely separate from the others, communicates with the third ventricle below the anterior commissure.

The third ventricle is not at first divided into an upper and a lower canal by the commissura mollis; but in the latter periods of fœtal existence this separation is more marked than in the adult.

The lateral ventricles are not divided at first into three horns, but are entirely single. The anterior and middle horns are developed the first when the corpus striatum forms. The posterior horn is the last to appear. The formation of the latter and this complete separation of the first two, depend on the thickening of the parietes of the hemispheres, and the increase in the size of the corpora striata.

4th. *Texture, consistence,* and *colour.* The nervous system in general, and particularly its central mass, are extremely soft in the early periods of life. It is curious, however, that notwithstanding this softness, its fibrous texture* is easily distinguished, and is even more evident than in the adult, even as in fishes we observe it in several parts of the cerebrum, without recurring to any artificial means to render it more evident. The fibres seem to be arranged in elongated and

* Petsche, *Syllog. obs. anat. select.*, Halle, 1736, p. 33, § 76.

pyramidal fasciculi, the summits of which are turned inward, and the bases of which look towards the surface of the cerebrum; at least we have observed this phenomenon several times in the brains of fœtuses macerated for a short time before or after their immersion in alcohol.

The difference between the grey and the white substance is visible at a later period. It appears earlier in the spinal marrow than in the cerebrum, where it is evidently formed from behind forward, and from below upward. It is already very evident at seven months in the spinal marrow, and perhaps even it is observed there sooner. The grey substance has then even a deeper tint than that which marks it afterward. But the medulla oblongata is still entirely grey towards the period when the embryo is fully grown. After this period we first see the pyramids whiten, then the olivary bodies are covered with white substance. The annular protuberance is still entirely grey externally in the first weeks after birth, although the longitudinal fibres, extended into the pyramids, which pass through it, are entirely white. The transverse fibres soon afterward also become white: the inferior and external before the superior and internal, which at two months are but few in number, and scarcely perceptible. The difference between the grey substance and the white substance is observed in the cerebellum during the latter periods of fœtal existence. The grey substance however is much greater there in proportion than in the adult. The yellow substance, situated between the grey and the white, rarely forms before the end of the first year, and it never appears in the course of the first six months.

The cerebral peduncles are still grey externally in the first periods of life, although the prolongations of the pyramids within them have already a whitish colour at this time. Some months after they are often entirely white on the surface. Sometimes however we have found them entirely grey in children five months old, while the white substance was completely developed in the medulla oblongata and the cerebrum. It is true they had then a brighter tint than the rest of the white substance. The black substance which is met with internally in the adult, is simply grey in the first year. The mammilliary eminences are usually entirely grey at five or six months.

The difference between the grey and the white substance already begins to show itself in the other parts of the cerebrum at the period of birth, or at least in the first few weeks of life. Their arrangement, however, then differs much from what it is afterward. The optic beds and the corpora striata are entirely grey, although having very manifestly a fibrous texture, or at least it is very difficult to distinguish the two substances, because the grey is but slightly coloured, and the white is greyish. On the surface of the corpora striata is a very vascular layer, giving them a redder and a deeper tint than belongs to them, and under this is a homogenous mass of a brighter colour and still entirely grey. There are developed in this layer yellowish white rays which perfectly fit with it, are still less abundant than it, and are not attached to those

of the cerebral peduncle: but we have not yet determined with certainty at what period they appear, although they are evidently formed in the first weeks after birth and not in the latter of fœtal existence. These yellow rays disappear in the course of the first month. At the same time the red and vascular substance is discoloured, and a medullary band, scarcely about a line broad, forms between it and the external grey substance, and gradually extends particularly inward.

This layer, formed alternately of red substance and of a yellowish white substance about six lines broad, presents a very marked analogy with the fimbriated nucleus of the olivary bodies and of the cerebellum. But the cerebrum differs from the cerebellum and the medulla oblongata, inasmuch as its corpus dentatum is only a temporary formation, while in the other two it is permanent.

The grey cortical substance is much thicker in the cerebrum in the early periods of life than subsequently. At five months its average measure of thickness is about two lines.

As the intermediate yellow substance is not developed in the cerebellum at this period, so too the envelop of the posterior circumvolutions of the cerebrum is not yet divided by an intermediate medullary band into an external and an internal layer; we must then attribute the absence of this arrangement to a suspension of development which is sometimes observed in adults.

V. ENVELOPS.

§ 1804. The pia-mater is generally much more vascular and much better developed, but also united much less intimately with the nervous substance the younger the fœtus is. The internal pia-mater seems to form gradually. The choroid plexuses seem to participate remarkably in this difference dependent on age; but they do not exist at all during the early periods, although the cavities which include them are already formed, so that the differences in their development depend according to all appearances less on the increase of the mass of the cerebrum than on the extent of its cavities, and they are in direct ratio with the activity of the secretion even as in the mammalia, where the ventricles are larger than those of man in proportion to the medullary mass, the choroid plexuses are also much more developed than in the human species.

The *arachnoid membrane*, if we except perhaps the first periods, is at first much more evidently distinct from the pia-mater and from the dura-mater in all its extent. It is also proportionally softer, thicker, and less transparent. We find between it and the other two membranes, and also in the cavities of the encephalon and the spinal marrow, during the early periods of life, much more fluid than exists afterwards. Its differences at different periods of its development are then most probably in direct ratio with its power of secretion, since when the latter is increased by a morbid state the membrane is changed

exactly in the same manner. It generally becomes less pellucid, thicker, and harder, as the subject grows older.

The *glands of Pacchioni* are not generally observed till at an advanced period of life.

The *dura-mater* is proportionally more vascular, but thinner and less distinctly fibrous in the early stages of life, than at a more advanced period. Its prolongations, particularly the perpendicular, are very thin, much less extensive, and easy to divide into two lateral layers in all their extent, so that considered generally they are but slightly developed. The connections between the skull and the cerebral dura-mater which is still imperfect, are much more intimate in the fœtus than in the adult. The substance between the spinal dura-mater and the vertebral column is at first much more abundant, but also thinner and gelatinous: it does not become changed into fat until after the first year of birth.

§ 1805. Notwithstanding all the researches hitherto made, the mode of the formation of the centre of the nervous system is not yet ascertained. Two of the characters presented by it at all periods of life are very much developed in the early states, viz. the ventricles and the two lateral corresponding halves. We may then conjecture that the central portion of the nervous system forms in the centre of a fluid and down it, that it there assumes the form of a hollow canal, or that it is developed there in layers or cords more or less separated on the median line, which gradually unite to form a cavity. In this latter hypothesis, the number of degrees of development through which the cerebrum and spinal marrow pass would be greater than in the first, which does not admit of the primitive simple form of layers. But there are facts which favour the latter opinion, and although it renders the formation of the central mass of the nervous system more complex, we must not discard it to admire wrongly the simplicity of nature in her operations. The facts we allude to are the almost entire division of the spinal marrow into two lateral portions, which is seen from the first, the possibility of entirely separating also the anterior cords from each other, and thus of changing the spinal cord into two lateral cords: the great breadth and the slight thickness of the medulla oblongata; finally the total separation of the two lateral halves of the cerebellum, probably also of the tubercula quadrigemina, and very certainly of the optic beds. Thus the central mass of the nervous system is developed from below upward, although we are as yet unable to determine if it is by one or two layers: these layers cross from before backward, curve inward to meet each other and blend on the median line, giving rise in this manner, first to a semi-canal and then to a perfect canal. This theory is supported not only by the facts supplied by the history of the fœtus, but also by the development of the nervous system in the animal kingdom. The dorsal medulla and the cerebrum of worms and insects evidently correspond to the inferior or anterior cords of these same parts in the upper classes of animals, and we may without much

trouble extend a higher degree of organization to these organs, partly by supposing the superior cords to be added, and partly by supposing them united posteriorly, by which the layers or cords which first existed assume the form of a canal.

The final development of the central part of the nervous system is by the increase of the mass, which augments the thickness of the parietes of the ventricles, and contracts the latter. Next supervenes a period when the mass settles, so that the surface which was at first smooth and united becomes very uneven, and at the same time much more extensive. Differences then occur in the nervous substance which divides into grey and white, by which phenomenon the development of its intimate structure terminates. These different characters generally appear in the parts in the same order as they are formed. The spinal marrow is first perfected in every respect. The tubercula quadrigemina change but slightly after birth. The cerebellum seems to be an exception to the rule, for although it is formed late, it becomes perfect in respect to form and texture long before the cerebrum, and even before the annular protuberance.

CHAPTER V.

OF THE MOTIONS OF THE CENTRAL MASS OF THE NERVOUS SYSTEM.

§ 1806. The central mass of the nervous system has certainly two motions,* which are very evident in the brain. One depends on the pulsation of the arteries, the other on respiration; of these, the latter is much less frequent than the former. Both consist in an alternate rising and falling of the encephalon, which in the second is undoubtedly enlarged and contracted alternately. Respiration determines the second kind of motion, because when the air is expelled from the lungs it is more difficult for the blood to return to the brain, while on the contrary, its return is more easy during inspiration. The encephalon enlarges then in the first of these two cases, and collapses in the second.

* Schlichting, *De motu cerebri*; in the *Mém. prés.*, vol. i. p. 113.—Lorry, *Sur les mouvemens de cerveau et de la dure-mère* same journal, vol. iii. mem. i. p. 277, mem. ii. p. 344.—Haller, *Experim. ad motum cerebri a refluxu sanguinis natum*; in the *Opusc. phys.*, vol. i. p. 231.—Lamure, *Sur la cause des mouvemens du cerveau*; in the *Mém. de Paris*, 1753.—Richard, in the *Journ. de méd.*, vol. xxix. 1768, p. 140.—Ravina, *De motu cerebri*; in the *Mem. de Turin*, 1811.—Portal, *Mém. sur un mouvement qu'on peut observer dans la moelle épinière*; in the *Mem. sur plus. malad.*, vol. ii. p. 81.—Magendie, *Sur un mouvement de la moelle, épinière isochrone à la respiration*; in the *Journ. de phys. expér.* vol. i. p. 200.

CHAPTER VI.

OF THE CENTRAL PORTION OF THE NERVOUS SYSTEM IN THE ABNORMAL STATE.*

§ 1807. Most of the deviations in the formation of the central part of the nervous system are congenital. They all relate to the *existence*, the *number*, the *situation*, the *size*, and the *form* of this mass.

§ 1808. *Existence* and *number*.† Not unfrequently a greater or less portion of the central mass of the nervous system is deficient by a primitive deviation of formation. In *acephalia vera*‡ the spinal marrow is usually developed as far as the vertebral column extends, and in this place terminates in a point, where it divides like the cerebrum into two rounded eminences. The cerebrum is then entirely deficient, or at least exists but very imperfectly, except when there is a rudiment of a head in *spina bifida* and in *acephalia falsa*, which is similar to *spina bifida* and which frequently coexists with it. The cerebrum

* J. Baader, *Obs. med. incisionibus cadaverum anatomicis illustratæ*, Friburg, 1762.—J. F. Meckel, *Rech. anat. physiol. sur les causes de la folie*; in the *Mém. de Berlin*, 1764.—J. E. Greding, *Melancholico-maniacorum et epilepticorum quorumdam in ptochotropheo Waldhemiensi defunctorum sectiones*; in Ludwig, *Advers. med. pr.*, Leipsic, 1771, vol. ii. iii.—Burdach, *Beytrâge zur nâhern Kenntnis des Gehirns in Hinsicht auf Physiologie, Med. und Chirurgie*, Leipsic, 1806.—Home, *Observations on the functions of the brain*; in the *Phil. trans.*, 1814, vol. ii.—Lallemand, *Observations pathologiques propres à éclairer quelques points de physiologie*, Paris, 1818.—J. Abercrombie, *Ueber die Krankheiten des Gehirns und des Rückenmarks*; with additions, Nasse, Bonn, 1820.—Id., *Observats. sur l'inflammation chronique du serveau*; in the *Journ. compl. des sc. méd.* vol. i. p. 346.—Lallemand, *Recherches anatomico-pathologiques sur l'encéphale et ses dépendances*, Paris, 1820 et suiv.—Georget, *De la folie, considerations sur cette maladie, suivies de recherches cadaveriques*, Paris, 1820.—Geoffroy-Saint-Hilaire, *Philos. anat., monstruosités humaines* Paris, 1823.—Serres, *Recherch. sur les malad. organiques du cervelet*; in the *Journ. de phys. exp.*, vol. ii. p. 172, 249, vol. iii. p. 114.—C. Oppert, *Diss. de vitiis nervorum organicis*, Berlin, 1815.—Magendie, *Hist. d'une maladie singulière du système nerveux*; in the *Journ. de phys. exper.* vol. ii. p. 99.—A. L. J. Bayle, *Mémoire sur quelques points de la physiologie et de la pathologie du système nerveux*; in the *Reveu médicale*, vol. i. p. 46.—L. Martinet, *Observations tendantes à éclairer la doctrine des phénomènes spasmodiques dans les cas de ramollissement du cerveau*; same journal, vol. i. p. 56.—A. L. J. Bayle, *Mémoire sur l'existence de la paralysie du même côté que la lèsion cerebrale qui la determine*; same journal, vol. i. p. 33.

† The following terms have been proposed for the deviations in the formation of the central mass of the nervous system which may appertain to this class: *aneuria*, the deficiency of the whole nervous system: *amyelencephalia*, simultaneous absence of the encephalon and spinal marrow: *amyelia*, entire absence of the spinal marrow; *atelomyelia*, imperfection of the spinal marrow; *anencephalia* absence of the encephalon. F. T.

‡ The most complete treatise on acephalia, is that of Tiedemann, *Aanatomie der kopflosen Missgeburten*, Heidelberg, 1813.—See also Tiedemann, *Beobachtungen über Missbil dungen des Gehirns und seiner Nerven*; in the *Zeitschrift fur Physiologie*, part i. 1824, p. 55.

and the spinal marrow are frequently partly or wholly deficient although no mark leads us to suspect that they have existed anteriorly.

When the facial portion of the skull is imperfectly developed, the anterior part of the encephalon is also deficient, or at least, is very imperfectly formed. The anomaly generally extends only to the cerebrum: the medulla oblongata is rounded before, especially when there is no trace of the cerebrum, or when the latter is replaced by a thin vesicle, although we cannot trace the hemispheres, the corpora striata, or the optic beds.

More rarely only some parts of the spinal marrow and encephalon are deficient, while these two organs and the whole body are otherwise perfectly developed.* The commissures are most frequently deficient, a very curious phenomenon, as these parts are formed latest in the animal series and in the fœtus. The commissura mollis of the optic beds is most often absent;† but this is developed latest in the embryo, and birds are destitute of it. The corpus callosum is more rarely wanting,‡ and the annular protuberance still more rarely in subjects where the cerebrum and the cerebellum are regularly developed in all other parts. We know of no instance of the want of an anterior and posterior commissure, which is completely formed in the fœtus and in the animal series before the parts of union above mentioned.

Authors frequently mention the absence of the pineal gland and its concretions; but the pretended deficiency of this gland depends doubtless upon a careless or too hurried dissection.

The imperfect development of inequalities on the external and internal surface of the cerebrum, is connected with the total absence of parts which possess a great character of individuality. Malacarne states that the intellectual faculties are developed directly in proportion to the number of the layers of the cerebellum, which vary from six hundred to eight hundred. So too the external surface of the cerebrum is sometimes more or less smooth, a circumstance which perhaps is also connected with the degree of intelligence, for of all parts of the encephalon the circumvolutions vary the most.|| In regard to the internal eminences, the prominence of the posterior horn of the lateral ventricle is deficient more frequently than that of the middle horn. The imperfect development of the external circumvo-

* Breschet has observed in an idiot three years and a half old, an imperfect development of the outer part of the left hemisphere, the corpus striatum, and the optic bed of the same side, (*Note sur des enfans nouveau nés, chez lesquels l'encephale offrait un developpement imparfait*; in the *Journ. de phys. exp.*, vol. p. 232).

† We have reported previously several instances. Greding (*loc. cit.*, vol. iii. p. 650) observed, that of the greater number of brains he has dissected, the commissura mollis of the optic beds was deficient in seven only.

‡ Reil, *Archiv. für die Physiologie*, vol. xi. p. 311.—Meckel, *Handbuch der pathologischen Anatomie*, voi. p. 301.—Wenzel, *De penit. structurâ cereb.*, p. 302.

§ *Neuro-Encefalotomia*, Pavia, 1791.

|| Wenzel, chap. iii.

lutions is not unfrequently attended with an analogous arrangement of the internal eminences : but perhaps it is not so correct to admit the relation of cause and effect between those two states, for instance to attribute the second to the first,* as to ascribe the origin of both to the same cause.

The deviations in formation by excess are much less common than those by defect, particularly when the body is single, and they at most affect only insignificant parts. Here we may mention among others the existence of a small prolongation of the decussation of the optic nerves which goes forward,† and is perhaps only a repetition of the hypothesis, the increase of the number of the internal and external prominences which is little less frequent, the doubling of the commissura mollis of the optic beds, finally the existence of a double pineal gland,‡ although this anomaly depends perhaps on the division of the pineal gland, which is generally single.

2nd. *Situation.* The anomalies in respect to situation generally depend on the imperfect manner in which the organs which surround the spinal marrow and the encephalon are developed in *spina bifida* and in *acephalia falsa,* whence they are left more or less exposed.

In *encephalocele* (*hernia cerebri*) a greater or less portion of the encephalon projects outward, and is or is not covered by the common integuments.|| This hernia which generally supervenes after a congestion of serum within the encephalon or the skull, usually occurs either through one of the points of the osseous envelop which always continue open, as the occipital foramen, or through one of those spaces which are gradually filled up, as the fontanelles.

We have as yet no well authenticated instance of anomalies in the respective situation of the parts of the encephalon.

3rd. *Volume.* Excess and deficiency in volume are not rare phenomena in the central part of the nervous system. Both may be primitive and congenital, or consecutive and accidental.

a. Smallness. The spinal marrow is rarely too small from a primitive deviation of formation ; and it sometimes diminishes in *tabes dorsalis.*||

* Greding, *loc. cit.*, vol. iii. p. 613.

† Wenzel, p. 147.

‡ Sœmmerring, in Noethig, *De decussatione nervorum, opticorum,* Mayence 1786.

§ Meckel, *Handbuch der pathologischen An.*, vol. i.—Neagele, *Sur l'encepha locele*; in the *Journ. compl. des sc med.*, vol. xiii. p. 207.

|| The wasting of the spinal marrow has been observed by Bonet (*Sepulchretum.* vol. i. p. 305, 307). Morgagni has often remarked that the spinal marrow in persons affected for a long time with hemiplegia, was considerably diminished in all, the lateral portion corresponding to the side affected. (*De sed. et caus.*, ep. xi. sect. 60). This wasting has been observed also by Salzmann, Chaussier, Olivier. It seems to be generally attendant on old age, and may supervene whenever there is a slow and long continued compression of the spinal prolongation, as in the disease of Pott. We have even known in some cases of this kind, the medulla to disappear entirely at the part compressed. Olivier mentions a remarkable instance of it (*loc. cit.*, p. 143). F. T.

The encephalon presents instances of this deviation of formation much more frequently at birth. In *acephalia falsa*, *hemicephalia*, and in *microcephalia*, the cerebrum is exposed and is frequently developed perfectly, except in its volume. We can then hardly suppose that it has been affected by external compression, or admit that when it is partially or entirely deficient it has always pre-existed, and has been destroyed; but we have every reason to think, that in many such cases, any obstacle whatever, for instance, an accumulation of serum either between this viscus or between it and the skull, has prevented its normal development, and has destroyed it. This conjecture is strengthened by the analogy presented by the heads of monsters of this species with those of children affected with hydrocephalus, by the traces of an old or actually existingc ongestion of serum often found in membranous sacs hanging on the outside of the head: finally, by a phenomenon which frequently occurs under the eye of the observer, the change of hydrorachitis into the denudation and destruction of the spinal marrow. As the cause of suspended development of the cerebrum, the abnormal accumulation of serum, is only the continuance at one of the temporary degrees through which the organ successively passes in its formation, it is easy to refute all objections made against this theory, by alleging that similar anomalies occur simultaneously in other organs, that monsters which present instances of it are all similar to one another, and that they are more common in the female sex.* We however do not think that a mechanical obstacle of this nature is always necessary, since the cerebrum is formed later than the spinal marrow, and even when there is no external obstacle, it is at first very small in proportion to the spinal marrow and the body, and particularly its hemispheres appear last, and are at first proportionally very small.

* The observations of the ancients on this doctrinal point, are collected in Morgagni, *De caus. et sed. morb.*, ep. xii. 6.—Sandifort, *Anat. infantis cerebro destituti.* Leyden, 1784.—Sœmmerring, *Abbild. und Beschreib. einiger Missgeburten*, 1791 —Meckel, *Handbuch der pathol. Anatomie*, vol. i. p. 193.—Tiedemann, *Beobachtungen üeber Missbildungen des Gehirns und seiner Nerven*, in the *Zeitschrift für Physiologie*, vol. p. 56. Among those collected by the moderns, we shall mention the following:—

1st. Females. Pullin, in the *Med. and phys. journ.*, vol. i 1799, no. 3. p. 224.—*Id*, *ibid*, vol. iii. 1800, no. 12, p. 138.—Pole, *Case of extraordinary malformation in a fœtus;* same journal, vol. iii. no. 15, 1800, p. 397.—Beclard, in the *Bullet. de la fac. de med.*, 1812.—Burrows, *A case of malformation of the head*; in the *Med. chir. trans.*, vol. iv. p. 52.—Lawrence, *Account of a child born without a brain*; same journal, vol. v. p. 165.

2nd. Males. Cam, *A case of monstrosity*; in the *London med. and phys. journ.*, vol. vii. no. 39. 1802, p. 385.—Osiander, in the *Gœtting. Anzeig.*, 1812, p. 1377, 1388.—Kelch, *Beytrage zur patholog. Anatomie*, Berlin, 1313, p. 83.—*Account of four male children born without a brain*; in the *London med. and phys. journ.*, vol. xxxiv. no. 198, 1815. p. 104.

3rd. Undetermined. Two cases by Simmons, in the *Lond. med. and phys. journ.*, vol. iv. no. 19, 1800, p. 189 —Two others by Beclard, in the *Bullet. de la soc. de med.*, 1813, no. 1.

From the extreme smallness and the denudation of the encephalon, life is generally very short, continuing only for a few hours; sometimes, however, it remains several weeks.* When the wasting of the organ is not so extensive, the individual can live, but his intellectual faculties are imperfect. Instances of this anomaly are seen in idiots† and cretins;‡ in them the cerebrum is characterised principally by the smallness of its anterior and upper parts, or by its slight extent from one side to the other, by which its height or its breadth § are diminished.

It is still less probable that a diminution, a *wasting* of the encephalon, is attended with a diminution of the activity of the mind, since not only the nerves but the parts of the cerebrum to which they correspond, diminish and waste when their action has long been suspended.

Thus many anatomists, particularly Wenzel, ‖ have noticed the wasting of the optic beds, and Gall of that of the anterior tubercula quadrigemina in blind people. Wenzel has determined, by very minute researches, that in blindness the optic beds first flatten and then become narrower and shorter.

b. Sometimes the whole central mass of the nervous system or some one of its parts, are larger than when normal. Here, as in similar anomalies of the vascular system, we must distinguish simple dilatation from real enlargement.

Simple dilatation occurs in dropsy of the ventricles where the cerebrum is enormously distended, but is only a few lines thick; and when the congestion of serum is very abundant, its mass is even smaller than in the normal state.¶

But the cerebrum in children affected with rachitis presents on the contrary an abnormal enlargement in mass. **

* We have collected the cases of this kind in our *Handbuch der pathol. Anatomie*. To those already mentioned, we may add the following: Harder (*Pæon et Pythag.*, p. 125, c. 22.) mentions a child with this affection which lived ten days. Osiander (*Gœtting. Anzeig*, 1812, pp. 1387, 1388) has seen a boy in whom the medulla oblongata and the cerebellum were regular, and the cerebrum was but a slight rudiment, although possessing small cavities and the cortical and medullary substance, which lived fifteen days; it enjoyed good health during twelve, and died from the consequences of a disease of the mother. Lawrence (*Med. chir. trans.*, vol. v., mentions a female child who lived four days, and Burrows (*Ibid*, vol. ii.) another, who existed six days.

† Rœderer, *De cerebro observ.*, Gœttingen, 1758, p. 5.—Greding, *loc. cit.*, vol. iii. p. 594.—Siebold, *Journal fur Gebertshilfe*, vol. i. part ii. 259-265, 272-278.

‡ Wenzel, *Ueber Cretinismus*, Vienna, 1812.—Ackermann, *Ueber de Cretinen*, Gotha, 1790.

§ We find the skulls of idiots and cretins which possess an analagous formation of the cerebrum figured in Prochaska, *Disq. org. corp. hum.*, Vienna, 1812, tab. 8-10.—Blumenbach, *De nisus format. aberr.*, Gœttingen, 1813, tab. 2.

‖ *De penit. struct. cereb.*, p. 125.

¶ Home, *Observat. on the functions of the brain*; in the *Phil. trans.*, 1814.

** Ludwig, *Adv. Méd. pr.*, vol. ii. p. 221.

The spinal marrow is sometimes larger than usual in *spina bifida*, as it is then found entirely filling the vertebral canal.*

The increase of some parts of the central mass of the nervous system is rather a rare phenomenon. Sometimes however we find the fourth lobe of the cerebellum, † the pineal gland, ‡ the pituitary gland, § the optic beds, and the corpora striata, || larger than usual.

This anomaly is not always essentially the same. Hydrocephalus, the enlargement from rachitis, the abnormal length of the spinal marrow, the largeness of the prolongations, and of the pituitary gland, should undoubtedly be considered as a continuation of development after a type which is regular only in the early periods of life, since it is easy to demonstrate that these phenomena are normal in the early periods of existence.

The abnormal enlargement of the optic beds seems intended to compensate for the wasting of one of these two eminences, as these two states are usually seen simultaneously.

4th. The cerebrum and the spinal marrow rarely present primitive deviations of formation not included in one or another of the preceding classes.

In *spina bifida* the spinal marrow is sometimes flatter and broader than usual, or even divided into two halves, which manifestly indicates a suspension of development.

Among the deviations in the formation of the cerebrum, we may arrange the following:—

a. The mutual and perfect adhesion of the two hemispheres which is observed without any injury of the intellectual functions, and which sometimes occurs in all the inner faces of the hemispheres, ¶ sometimes is confined to some points of these same surfaces,** which remarkably increases the number of the commissures, when, as in the cases cited in the note, the two halves of the cerebrum are continuous. An arrangement similar to this is where there is an intimate adhesion of the inner faces of the hemispheres by a close cellular tissue.†† In both cases the large cerebral falx is more or less imperfect. The deficiency of this prolongation of the dura-mater, ‡‡ the first degree of which, the existence of one or more openings which pass through it in different parts, and which is quite common, is curious as an analogy with the formation of most animals.

* This has been observed several times by Laennec.

† Kelch, *loc. cit.*, p. 90.

‡ Blane, in *Trans. of a soc. for the improv. of med. and surg. knowl.*, London, vol. ii. p. 16.

§ Greding, *loc. cit.*, vol. ii. p. 515.

|| Wenzel, *loc. cit.*, pp. 125, 126.

¶ Carlisle, in the *Trans. of a soc. for the improv. of med. and surg. knowl.*, vol. ii. p. 212.

** Wenzel, *loc. cit.*, p. 288.

†† Greding, *loc. cit.*, vol. iii. p. 630.

‡‡ Gunz, *De lapillis gland. pinealis*, p. xi.

3. *Defect in symmetry*, the obliquity of the cerebrum, which involves a corresponding obliquity of the head, and often also mental alienation,* although this latter does not attend it necessarily. This defect sometimes exists to such a degree that, at least if we may judge from appearances, one half of the cerebellum is twice or three times as large as the other.†

Wounds of the central part of the nervous system endanger the life of the person wounded, and the more the nearer they are to the medulla oblongata.‡

1809. *Alterations of texture.* We may arrange under this head the following alterations:—

1st. *Differences in consistence.* The spinal marrow has been studied but slightly in this respect.

The degree of consistence of the cerebrum is not always perfectly the same, nor are the anomalies presented by it always attended with the same derangements of the intellectual faculties.

a. Induration. § Of this there are several degrees. If very extensive, the tissue of the cerebrum is at the same time more or less altered, and earthy particles || are even mixed with it. When this occurs, it is sometimes hard to cut the cerebral substance at those places where the induration exists. The cerebrum not unfrequently becomes more consistent in mental alienation,¶ and the intellectual faculties are more affected the greater the hardness of the cerebrum.**

b. Softening. †† The induration of the cerebrum, notwithstanding the facts we have mentioned, is in general so slightly a necessary condition of mental alienation, that we much more frequently find the contrary state, the softening of the organ; excellent observers, who have had opportunities of seeing, have determined this fact.

* Greding, *loc. cit.*, vol. ii. p. 525, 595, vol. iii. pp. 453.

† Greding, *loc. cit.*, vol. ii. p. 525.

‡ See the excellent memoir of Casper, *Sur les lesions de la moelle épinière, par rapport à leur degre de lethalitè*; in the *Journ. compl. du. Dict. des sc. med.*, vol. xvi. p. 309, vol. xviii. p. 107.

§ S. Pinel, *Recherches d'anatomie pathologique sur l'endurcissement du système nerveux*; in the *Journ. de phys. exp.* vol. ii. p. 191.

|| Morgagni, *De sed. et caus. morb.*, ep. an. i. 10, 17, viii. 14.—Marshal, *Morbid anatomy of the brain in mania and hydrophobia*, London, 1815. Sixteen times in twenty-four cases.

¶ We find two cases in Home, *loc. cit.*—Portal, *Anat. med.*, vol. iv. p. 110.

** Greding, *loc. cit.*, vol. ii. p. 533, vol. iii. p. 662.

†† The softening of the cerebrum is a subject of important research to the French pathologists, a very general picture of which would be too extensive for a place here. We refer to the article *cephalite* in the *Dictionnaire des sciences medicales*, and to the good remarks of Lallemand. See also Rostan, *Recherches sur le ramollissement du cerveau*, Paris, 1828. We will only remark that Lallemand considers this morbid organic alteration as the result of inflammation of the cerebrum. His opinion is that which is most followed in France, where it is almost universally adopted. No one now denies, that in most cases of *ataxic* diseases, that is, with complicated symptoms of excitement and of diminution of the action of the encephalon, where the encephalon is found perfectly regular, more or less extensive softening of the cerebral substance appears. F. T.

The consistence of the cerebrum also is very commonly increased in some parts, and diminished proportionally in others, but in subjects affected with mental derangement,* and with dropsy.† This state of the cerebrum is even common in fools.‡

But none of these states are necessarily connected with idiotcy in general, or with its different species in particular, for the cerebrum has been found of the normal consistence in every species of mental derangement.§

The cerebrum has been found much harder or softer than usual in subjects whose intellectual faculties were unimpaired.‖

The cerebrum in idiocy has been found not only more or less consistent than usual,¶ but often of a normal consistence, or uncommonly soft, or finally too soft in some parts and too hard in others.** So too in madness it has been found too soft †† and too hard.‡‡

2d. *Dropsy.* Dropsy of the centre of the nervous system (*hydrorachitis* and *hydrocephalus*) is very common, especially in the early periods of life, and is often congenital. We have every reason to think that in this case it arises from suspended development.

In *hydrorachis* the serum is generally accumulated around the spinal marrow, most generally between it and the archnoid membrane, more rarely between this membrane and the dura-mater, very rarely or even never between this membrane and the bones. When the congestion exists in the greatest degree, it opposes the development of the arches of the vertebræ to a greater or less extent, either in one or in several points, where the serum accumulated in the vertebral canal distends the membranes and the skin so as to form a tumor, which is more or less prominent, and which finally breaks.§§

Most generally hydrorachis is attended with *hydrocephalus*, which is generally distinguished into *acute* and *chronic.* ‖‖ The congestion

* Home, *loc. cit.*—Portal, *loc. cit.*, p. 119.
† Portal, *loc. cit.*, p. 75.
‡ Greding, *loc. cit.*, vol. iii. pp. 664, 665.
§ Greding, *loc. cit.*, vol. ii. pp. 532, 533, vol. iii. p. 662.
‖ Morgagni, *De caus, et. sed. morb.*, ep. viii. 18, lxi. 8.
¶ Meckel, *Recherches anat. phys. sur les causes de la folie*; in the *Mem. de Berlin*, 1764, obs. 1-6.
** Greding, vol. ii. p. 557, vol. iii. pp. 662, 665.
†† Meckel, *loc. cit.*, p. 71.
‡‡ Greding, *loc. cit.*, vol. ii. p. 537, vol. iii. pp. 664, 665.—Home, *loc. cit.*—Portal, *loc. cit.*

§§ This tumor is most frequently situated in the loins, more rarely in the back, often in both of these places at once, rarely in the neck, rarely also in the sacrum, where it has been seen among others by Vrolik (*Memoires sur quelques sujets interressans d'anatomie et de physiologie*, trans. by Fullot, Amsterdam, 1822, p. 761. F. T.

‖‖ Breschet, *Recherches anatomiques et chimiques sur une hydrocéphale chronique*; in the *Journ. de physiog. experimentale*, vol. i. p 93—Id., *Note sur deux enfans nouveau nés hydrocéphales et manquant de cerveaux*, same journal, vol. ii. p. 269.—J. L. Brachet, *Essai sur l'hydrocéphalite, ou hydropise aiguë des ventricules du cerveau.* Paris, 1818—Coindet, *Mem. sur l'hydrocéphale*, Geneva, 1817—Bricheteau, *Mémoire sur l'hydrocéqhale interne*; in the *Journ. compl. des sc. méd.*, vol v. p. 193.

of the serum is situated sometimes in the cerebral ventricles (*hydrops cerebri, hydrencephalus)*, sometimes on the surface of the brain between the arachnoid membrane and the dura-mater; finally, sometimes and most commonly in both these parts; in all these cases the arachnoid membrane is that which is primitively diseased. The cerebrum itself is always more or less softened. When the serum is accumulated principally or solely in the ventricles, these cavities are dilated in proportion to its quantity, the substance of the cerebrum becomes thinner, and the circumvolutions are flatter. The latter are finally entirely defaced, when the cerebrum is distended and is considerably thin. When on the contrary the serum is collected on the surface of the brain, the latter collapses in proportion to its quantity.

The mass of the cerebrum is less than in the normal state, at least when there is a considerable congestion of serum, and when it takes place slowly.

Notwithstanding the normal communication between the cerebral ventricles, the serum is accumulated sometimes in only one of these cavities,* which proves that the openings have been obliterated by an inflammatory effusion, and not as is pretended † that they do not exist.

Chronic hydrocephalus is most generally congenital, and probably even original. It depends then on the cerebrum continuing to grow after a type of first formation.‡ This is perhaps, at least in part, the reason why it often continues so long without necessarily deranging the intellectual faculties, even as the rupture of the septum of the heart is fatal, while its original perforation seems not to endanger life, which continues sometimes to an advanced age, notwithstanding this anomaly.

3d. *Inflammation.* The substance and the envelops of the encephalon and spinal marrow may be inflamed. They then receive more blood than usual.

Wenzel has asserted that the pituitary gland always presents traces of inflammation and its consequences in idiopathic epilepsy.§ Presented in this general manner the assertion is false, as is proved by the facts collected by several observers,‖ and by ourselves.

vol. vi. p. 302, vol. vii. p. 97—John, *Recherches chimiques sur la liquer que les ventricules du cerveau renferment dans l'hydrocéphale*; same journal, vol. vi. p. 270. Consult also Coutanceau, *Des épanchemens dans le crâne pendant le cours des fièvres essentielles*, Paris, 1802, the excellent article *Hydrocéphale* by Itard, in the *Dictionnaire des sciences médicales*, the article *Hydrocéphale* by Boisseau, in the *Dictionnare abrégé des sciences médicales*, and Ducrot, *Essai sur la céphalite*, Paris, 1812.

* Tulp, *Obs. méd.*, I. c. 25.—Wepfer, *Obs. anat. de apoplexie*, Scaffhousne, 1675, p. 68—Portal, *Mém*, vol. ii. p. 58—Monro, *On the brain*, p. 18.

† By Portal among others.

‡ See our *Handbuch der pathologischen Anatomie*, vol. i.

§ *Observations sur la glande pituitaire dans l'èpilepsie*, Paris 1811.

‖ For instance Kelch, *loc. cit.*, p. 103.—Otto, *Seltne Beobachtungen*, 1816, p. 106.

Among the membranes the arachnoid is particularly liable to inflame. Hence the results of inflammation are observed most frequently in it.* Here we include,

a. The thickening of its substance, the result of exsudation.

b. The formation of yellowish white corpuscles, the *glands of Pacchioni* which are developed in several regions, particularly in the sinciput, and which are seen more particularly in maniacs and persons who have been subject during life to congestions of the brain.†

c. The effusion of pus between the parts of the arachnoid membrane which line the dura-mater and the pia-mater.

d. Very probably the abnormal new formations, ossification, &c.

The inflammation of the cerebral substance ‡ is very remarkable, particularly in respect to its consequences, inasmuch as not unfrequently this substance is destroyed even to a very considerable extent, although for a long time such a disorder has caused no marked derangement in the functions of the cerebrum, and has not manifestly endangered the life of the patient.§

Sometimes the pus found in the cerebrum is contained in special cysts,‖ which phenomenon cannot be explained better than in saying that it is not the cerebral substance which separated, but an accidental tissue developed within it, for,

a. The cysts adhere but slightly to the cerebral substance which surrounds them.

b. The latter is not hardened but softened around them.¶

* Parent-Duchatelet and Martinet, *Recherches sur l'inflammation de l' arachnoid cérébrale et spinale*, Paris, 1821.—Deslandes, *Examen des diverses formes que peut prendre la phlegmasie des méninges*, Paris, 1817.

† Meckel, *loc. cit.*, p. 77.—Greding, *loc. cit.*, vol. ii. p. 471.—Wenzel, Prod., cap. i.

‡ Inflammation of the substance of the cerebrum has been termed *encephalitis*, or *cerebritis* and *cerebellitis*, when confined to the cerebrum or cerebellum (Lallemand, *loc. cit.*); that of the spinal marrow is termed *myelitis*, which is a better term than *rachialgia* and *spinitis* (Klohs, *Diss. de myelitide*, Halle, 1820—Harles, *Ueber die Entzundung des Rückenmarks.*—Clot, *Recherches et observations sur le spinitis* Montpellier, 1820.—Brera, *Della rachialgite*; in the *Atti dell academia di Livorno*, 1810—Bergamaschi, *Osservazioni sull' inflammazione della midolla spinale*, Pavia, 1810). In the encephalon, and even in the spinal marrow, inflammation seems usually to cause the softening and sometimes the induration of the medullary substance with the formation of abnormal tissues, or at least a tendency to this formation. It would seem as if this last effect, that is, induration, is more particularly the result of a slow, or as is generally termed, a chronic inflammation. F. T.

§ Since inflammation of the cerebrum has been more studied, we know better what to think of these cases. A softening of a few lines in diameter seems to cause death. If the same is not true, at least promptly, of a schirrous or even a cancerous change, it is because they take place slowly, and we may consider as a law of the organism, in the state of disease, that an alteration even extensive but slow, destroys life less surely and less rapidly than another less extensive but acute. F. T.

‖ Bateman, *Case of an encysted tumor, occupying the greater part of the right hemisphere of the brain*; in the *Edinb. med. and surg. journ.*, vol. i, p. 150.

¶ Brodie, *Case of abscess in the brain*; in the *Trans. of a soc. for the improv. of med. and chir. knowl.*, vol. iii. p. 106.

4th. *New formations.* Beside these alterations in the consistence of the cerebrum, which are mentioned above and which supervene, although none is observed in the texture, the composition, and the colour of this viscus, the centre of the nervous system is frequently also the seat of entirely new formations. These formations constitute a series of pathological changes which commence by manifest alterations of texture, which however unite with the rest of the mass, and which terminates by more or less distinct bodies which adhere but slightly to this mass.

The *cysts* filled with a fluid analogous to serum or thicker, should probably be considered as the first degree of these new formations, since the concrete fluid they contain has no determinate character. These cysts appear both in the substance of the cerebrum, cerebellum, and medulla oblongata,* and on their surface between the meninges and in the ventricles.† Those in the cavities of the ventricles are very common in the choroid plexuses, which are, generally speaking, the most usual seat of their development. They generally have thin parietes; but sometimes also, the membranes which form them are several lines thick. They are generally attached but feebly to the adjacent parts.

They vary much in size, from a head of a pin to a hen's egg. The largest particularly, and those situated in the cerebral substance, are almost always isolated, but the small, those developed externally and in the cerebral ventricles, are united in a greater or less number.

The abnormal repetitions, of normal tissues, other than that of the serous tissue on the surface or in the substance of the cerebrum, are rare. They perhaps occur only in the cartilaginous and osseous tissues.

The abnormal ossifications are most frequently situated in the arachnoid membrane, and occur like all the formations of this kind in advanced age. They seem to be rarer in the spinal than in the cranial portion of this membrane.‡ We have every reason, however, to believe that this difference depends in great part on the fact, that the spinal marrow is examined less frequently than the cerebrum, for Morgagni has seen them once, and we have observed them twice in this region. They assume the form of thin and irregular layers, which project more or less above the surface of the arachnoid membrane, and are found principally on its posterior side and its lower part, to which they often adhere but very slightly.

They are developed on the surface of the cerebrum, between the dura-mater and the arachnoid membrane; at least they almost always

* Portal, *loc. cit.*, p. 72.—Morrah, *A case of hydatids in the brain*; in the *Med. Chir. trans.*, vol. ii. p. 262.—Home, *loc. cit.*, p. 54.

† Buchanan, *Case of encysted tumour of the brain*; in the *Edinb. med. journ.*, vol. viii. p. 276.

‡ Morgagni, *De sed. et caus. morb.*, ep. 25, a. 9.—Sabatier, *Sur quelques particularités da la moelle épinière et de ses enveloppes*; in the *Mém. de Paris*, 1783, p. —Hertel, *De cerebri et meningum tumoribus*, Berlin, 1814.

form on the inner surface of the first, that is to say, in fact, on the external arachnoid membrane which lines it. Those which are considered as belonging to the pia-mater,* are always formed not from this membrane, but from the layer of the arachnoid membrane which covers it, since they are found on the external face of the pia-mater, and often adhere very strongly to the inner face of the dura-mater.† They vary much in their number, extent, figure, and degree of adhesion. Sometimes they are insulated, sometimes expanded in several parts, sometimes scarcely perceptible, and again several inches broad, smooth or rough, with even or serrated edges, sometimes adhering by a broad base, and sometimes only fitted to the membrane, to which they are attached only by a few filaments. Their situation is the only thing in regard to which certain generalities can be established with precision. They are most generally found on the large falx, or at least very near this fold, along the superior longitudinal sinus. Their influence on the cerebrum depends on the circumstances mentioned above, on the age of the subject, or on his greater of less susceptibility.

Besides these accidental ossifications, the tissue of the arachnoid membrane is sometimes, but more rarely, changed in an analogous manner. It becomes thicker, harder, and cartilaginous.‡

The ossification of the cerebral substance itself, or the development of osseous substance within the cerebrum, is on the contrary a very rare phenomenon. Very probably, in most of the cases where it has been admitted, there were only exostoses of the bones of the skull, which projected within this cavity, and caused the crowding or destruction of the encephalon. Sometimes, however, earthy substance has really been found accumulated in the cerebrum in so great quantity, that it was difficult to divide it with a cutting instrument:§ osseous concretions entirely distinct from the cerebral substance, have also been found, which were formed within it:‖ finally, bone and

* Greding, *loc. cit.*, vol. ii. p. 483, 485, vol. iii. p. 626, 628.

† Greding, *loc. cit.*, vol. ii.

‡ Greding, *loc. cit.*, vol. ii. p. 484.—Esquirol, in the *Bull. dè la fac. de méd.*, vol. v. p. 426.

§ Home (*loc. cit.*) has observed this peculiarity in the annular protuberance of a boy, an idiot from birth, and who at sixteen years, when he died, was only about the height of a child three years old. Andral has found in an individual who died of phthisis, on the upper surface of the left hemisphere, not far from its anterior extremity, and near a large fissure, a granulation of the volume of a large pea, having the consistence of calcareous concretions of the lung, and penetrate into the cerebral substance which they crowded; but perhaps it was only the ossification of the arachnoid membrane. (*Journal de physiologie expérimentale*, vol. ii. p. 110.) The same observer has found a kind of fibro-cartilaginous change of several circumvolutions of the two hemispheres of the cerebrum; the latter resisted like the fibro-cartilages when pressed between the fingers. In pulling them they are elongated, and then contract, and are very elastic; they had the colour of ivory, but no trace of the grey tint. Such indurations existed in the thickness of the hemispheres, and at their base (*loc. cit.*). The cartilaginous induration of the spinal marrow has been observed also by Birgamaschi and Portal.

‖ Greding, *loc. cit.*, vol. iii. p. 658, in the cerebellum.

cartilage have been met with in a cyst developed in the midst of the cerebral mass.*

It is not unfrequent to find, particularly in the cerebrum, entirely new formations, assuming the form of rounded tumors; but they are rarely or never developed in this viscus alone, and they are generally only portions of a mass of the same morbid formation existing in most of the other organs.† They differ from each other so much in respect to consistence, volume, number, and connections, that they must necessarily be referred to different species, between which, however, numerous intermediate degrees exist, as between all new and abnormal formations generally.‡

In respect to *colour*, these masses are whitish, of a yellowish white,§ reddish,‖ of a tint similar to that of cortical substance,¶ of a deep red,**or red and streaked with white.††

They are generally extremely solid,‡‡ whence they are often termed *schirrous*. Sometimes, however, they are spongy and soft, of a tissue which is soft and similar to that of the spleen.§§

Sometimes they are homogeneous, ‖‖ sometimes more or less evidently fibrous,¶¶ and composed of several rounded bodies.***

They sometimes become quite large, and have a diameter of from two to three inches.††† Sometimes they are single,‡‡‡ sometimes more or less numerous.§§§

* Hutchinson, *Case of disease in the brain*; in the *Med. chir. trans.*, vol. iv. p. 202.

† Reil, *Merorab. clin.*, vol. ii. f. I. p. 39.—Portal, *loc. cit.*, p. 92.—Earle, *A case of diseased testicles, accompanied with diseases of the lungs and brain*; in the *Med. chir. trans.*, vol. iii. p. 57.—Merat, in the *Journ. de méd.*, vol. x. p. 3.

‡ Among these tumours there are some which must be referred to the schirrous and encephaloid tissues, which Andral has observed once, both crude and softened from the level of the optic beds to near the base of the cerebrum (*Note sur le cancer du cerveau*, in the *Journal de phys. exp.*, vol. ii. p. 106). Hitherto Bayle is the only one who has well described the cancer of the cerebrum. We know as yet of no well authenticated case of cancer of the spinal marrow. Guersent, Pinel-Grandchamp, however, mentions a case of cancer of the medulla oblongata, which had principally destroyed the pyramids and olivary bodies (Ollivier, *De la moelle epiniere et de ses maladies*), and Andral (*loc. cit.*) has also found numerous tubercles in the cerebrum of a man who died of pleurtic effusion. Some were already suppurated and surrounded with softened cerebral substance. F. T.

§ Portal.—Reil.—Hutchinson.—Morgagni, *loc. cit.*, vol. xii. p. 15.—Bateman—Baillie—Ozanam, *Observations sur une affection tuberculeuse du cerveau*; in the *Journ. comp. du Dict. des sc. méd.*, vol. xix. p. 189.

‖ Merat—Salter, *Case of disease in the brain*; in the *Edinb. med., journ.*, vol. ii. p. 469.—Morgagni.

¶ Steinbach.

** Earle, p. 67.—Buchanan, *Case of encysted humour in the brain*: in the *Edinb. med. journ.*, vol. viii. p. 276.

†† Earle.

‡‡ Earle—Portal—Merat—Reil—Baillie.

§§ Buchanan, p. 279.

‖‖ Hutchinson.

¶¶ Salter.

*** Morgagni.

††† Merat—Earle.

‡‡‡ Buchanan—Merat—Hutchinson.

§§§ Merat, twice—Salter, once—Earle, seven times.

In certain cases they are imperceptibly continuous with the substance of the cerebrum, or at least adhere to it very intimately, but are not surrounded by a cyst.* In other cases they are slightly attached to the cerebral substance,† or are inclosed in a special cyst, usually with very thin parietes.‡

These abnormal formations do not always continue in the same state during all their existence. It is infinitely probable that they all tend sooner or later to suppurate, although death often occurs before this period, and the greater or less facility with which they suppurate, has no relation with their size. When suppuration attacks them, they resemble sacs which vary in thickness and are closed or open.§

New formations of a similar character are developed also in the envelops of the centre of the nervous system.

Among the meninges, they are situated principally in the dura-mater. They are termed generally the *fungi of the dura-mater,*‖ although all certainly do not belong to the same class, as they differ much in texture and form. They do not generally attack only the cranial portion of the dura-mater;¶ observers entitled to credit, have also proved their existence in that portion of this membrane which lines the vertebral canal, ** although there they seem to be less frequent in proportion.

Finally, we must place last the *foreign bodies* which are found principally within or on the surface of the central mass of the nervous system. Some arise from the greatest degree of the formative action, and these are the entozoaries. Others are liquids which are not always effused within or on the surface of the nervous system, from a change in its mode of action.

a. Entozoaries. The only intestinal worm which has certainly been known to exist in the encephalon is the *cysticercus cellulosæ,*†† which

* Reil—Hutchinson—Salter—Morgagni.

† Earle—Steinbach—Bateman—Brodie—Merat.

‡ Home. *loc. cit.*, p. 51.—Merat—Buchanan.

§ Brodie—Bateman.

‖ Louis, *Sur les tumeurs fongucusés de la pure-mére*; in the *Mém. de l'ac. de chir.*, vol. v. p. 1.—Wenzel, *Ueber die schwammigen Auswüchse der harten Hirnhaut*, 1811.—Walther, *Essai sur les fongus de la dure-mére*; in the *Journ. compl. des sc. méd.*, vol. vii. p. 118.—Esquirol, *Tumeur considérable developpée dans l'intérieur du crâne*; in the *Archiv. génér. de méd.*, vol. iii. p. 594.—C. B. Tilanus, *De fongosâ duræ meningis excrescente dissertatio*, Utrecht, 1819.—Heusinger compares these túmours to those described by the Germans, as *cephalomatoma*, which have been mentioned in Michælis. *Ueber eine eigene Art von Blutgescywûlsten*; in Loder, *Journ. für die Chirurgie*, vol. ii. cap. iv. p. 657.—Nægele, *Erfahrungen und Abhandlungen aus dem Gebiethe der Krankheiten des weiblichen Geschlechts*, Manheim, 1812, p. 215.—C. Zeller, *De cephalæmatomate, seu sanguineo cranii tumore recens natorum commentatio*, Heidelberg, 1822.

¶ Wenzel, *loc. cit.*, xxiii.

** Knox, in the *Med. obs. and inq.* vol. iii. p. 160.—Philipps, *New. med. journ.*, vol. i. p. 144.

†† Steinbach, *Cogitata quædam de vermium visceralium physiologia*, Erlangen, 1801.

occurs principally in the internal and external pia-mater, particularly in the choroid plexuses of the cerebral ventricles. The serous cysts often found in these bodies are very probably connected with its formation.*

b. The second class of foreign bodies is composed particularly of sanguineous effusions.

Not unfrequently there is an effusion either of pure blood or of a more or less bloody serum, either between the meninges or in the ventricles, or in the substance of the cerebrum and spinal marrow,† or finally between the dura-mater and the skull. This latter case is rather rare in the skull, and most generally results from an external wound. Such an effusion results sometimes in the more or less perfect and transitory or permanent and fatal suspension of the action of the cerebrum, *apoplexy*, sometimes the *paralysis* of the voluntary organs, according to its quantity and the place where it occurs.‡ It

* Of all the entozoaries, the *cysticercus cellulosa* is found most frequently in the encephalon, where it sometimes lives in the cerebral substance (*Zeitschrift für die Anthopologie*, 1823, part iii. p. 197); but Romberg has also found there *acephalocysts*, and Arnott the *echinococcus hominis* (*V.* Romberg, *Sur les entozoaires du cerveau*, in the *Journ. comp. du Dict. des sc. med.* vol. xix. p. 276). Esquirol mentions the existence of acephalocysts in the cavity of the arachnoid membrane of the spinal marrow (*Bullet. de la Fac. de med.*, vol. v. p. 426). F. T.

† But little attention has been paid to effusions of blood in the spinal marrow, where they are in fact rare. Home has found a clot of blood about two inches long in the centre of the organ, after a dislocation of the sixth cervical vertebra on the seventh (*Phil. trans.*, 1814). This internal hemorrhage sometimes occurs spontaneously, and forms a circumscribed effusion similar to those in the cerebral substance in apoplexy, but it would seem not to have been observed until at present, except in the upper part of the spinal marrow, or rather in the medulla oblongata, and even only beyond it in the annular protuberance. Serres mentions several cases of it (*Annuaire des hôpitaux*, 1819). When these effusions are but of slight extent, they may be resolved like those in the substance of the encephalon. Pinel Grandchamp has found in the left half of the annular protuberance of a cadaver, evident traces of an absorbed effusion, that is, a circumscribed cavity filled with a filamentous tissue, infiltrated with yellowish serum: the cavity would contain a common sized bean. Ollivier has described and figured this case (*loc. cit.*, p. 263. p. ii. fig. 3. a). Gautier-Claubry, however, has stated a case where there was an effusion of blood in a very great extent of the spinal marrow, which had become a semifluid reddish ball, similar to the deposit from red wine, and presented no trace of organization (*Journ. gen de méd.*, 1801). F. T.

‡ Deep wounds, compression by a portion of bone, by a foreign body, by an effusion of blood, serum or pus, the softening of the nervous substance may cause apoplexy or paralysis. Rochoux assigns as the character of apoplexy, caused by an effusion of blood, its manifestation by sudden paralysis. Lallemand thinks that the paralysis supervening after the combined phenomena of excitement and collapse, is caused by softening which arises from inflammation. If paralysis supervenes after symptoms of arachnoiditis, it is probably caused by a serous, sero-sanguineous or sanguineous effusion, which however, is situated in the ventricles or on the surface of the viscus. Serres, Flourens, Foville, Pinel-Grandchamp, and Lachampe-Lonsteau, have attempted after Willis, Morgagni, and many others, to determine the exact relations between the phenomena of paralysis and of lesion of the encephalon or of the spinal marrow. Their researches are contradictory. It only remains proved, as it had been before they attended to it, that the lesion is always on the side opposite to that paralyzed, and that the sanguineous effusions, the softening of the fornix, of the corpus callosum and of the septum lucidum, do not cause paralysis. F. T

does not necessarily suppose the laceration of the vessels; but it often and apparently most generally arises from a sanguineous exsudation from the capillary vessels.*

The cerebral arteries, however, are more exposed to laceration than the others from their feebleness, and this lesion generally seems to attack the middle large cerebral artery, at the lower extremity of the fissure of Sylvius.†

We can easily conceive that an effusion of blood in the substance of the cerebrum and spinal marrow, cannot occur without a rupture of the vessels.

These effusions seem to be more common in the corpora striata than in all the other parts of the cerebrum, on account of their softness: perhaps, however, it is more correct to say that those which occur in these eminences endanger life more than those in the other regions of the encephalon, especially in the hemispheres of the cerebrum where traces of old effusions are frequently seen.‡

When effusion does not cause death, we find traces of it long afterward. Such are the simple or multilocular spaces filled with a deposit of blood or of liquid serum, coagulated or mingled with cellular tissue, and often covered with a serous cyst, which are found in the cerebrum of those who have survived long after an attack of apoplexy, or who have been deprived for a greater or less length of time of the use of their intellectual faculties.§

This is, in fact, the course most generally employed by nature to heal the ruptures of the cerebral substance caused by the effusions of blood. In the rarest cases the effused fluid is entirely absorbed, and the rupture of the cerebral substance is entirely closed by a solid cicatrix.‖

* Wepfer, *Hist. apoplect.*, p. 5.—Cheyne, *On Apoplexy* London, 1812.

† Portal, *loc. cit.*, vol. iv. p. 80,—Wepfer, *loc. cit.*, p. 8.

‡ Rochoux has found in bloody effusions eighteen on the left, eleven of which were within the corpora striata, seven on the right, eight of which were in the same part, finally six on the two sides, three of which were in the same place. F. T.

§ Brunner, in the *Eph. nat. cur.*, dec. iii. a. i. p. 374.—Santorini, *Obs. anat.*, iii. § 6.—Morgagni, *De sed. et caus.*, ep. iii. 6. ix. 20, 23.—Cruveilhier. *Anat. pathol.*, Paris, 1816, vol. i. p. 205.—Rochoux, *Recherches sur l'apoplexie*, Paris, 1814. This author was the first who treated well of the alterations of the cerebrum which attend or follow the effusion of blood in this viscus. But the cysts which are developed around, and are termed apoplectic, have been described well only by Riobe (*Observations propres á résoudre cette question: L'apoplexie dans laquelle il se fait un épanchement de sang dans le cerveau est-elle susceptible de guérison?* Paris, 1814). —See also Bricheteau, *Considérations et observations sur l'apoplexie:* in the *Journ. compl. de sc. med.*, vol. i. p. 129. 289.—Consult also the treatise of Lallemand.

‖ We have lately received a new work of Gmelin, who on analyzing the brain of man and the ox, concludes from his researches that the pulpy substance contains, besides a fluid fat body, two other kinds of fat bodies, viz: 1st. a lamellar substance, similar in every respect to cholesterine, except that it contains a mixture of phosphorus, the quantity of which has not yet been determined: 2d. a small quantity of a substance similar to wax: this latter is the most fusible of all the fatty bodies, and

Sometimes the cerebral ventricles are so filled with blood that the substance of the encephalon is finally torn, and the liquid is effused through this opening on its surface between the meninges.

An effusion of blood (*apoplexia sanguinea*) is not, however, necessary to produce apoplexy, since the latter frequently supervenes, from an accumulation of serum either in the cavities or on the surface of the cerebrum, as in *apoplexia serosa*,* or even without any manifest change as in *apoplexia sine materia*.†

SECTION II.

OF THE PERIPHERY OF THE NERVOUS SYSTEM.

§ 1809. The periphery of the nervous system, comprehending the nerves properly so called, is divided into three sections; the *nerves of the spinal marrow* or the *spinal nerves*, the *nerves of the brain*, or the *encephalic nerves*, and the *ganglionary* or *great sympathetic nerve*. The number of these nerves, including the last, is forty-three pairs. But anatomists do not divide them in the same manner, for several cerebral nerves have been blended which are now considered as distinct pairs; and farther, some consider as cerebral nerves those which others refer to the spinal pairs.

We shall point out the differences arising from the first of these sources in our general remarks on the cerebral nerves. Those which arise from the second depend principally upon the division of the central mass of the nervous system. If the medulla oblongata be considered as the summit of the spinal marrow, we must naturally arrange the nerves arising from it among the spinal pairs; hence their number is increased, while that of the cerebral pairs is diminished.

Thus Gordon admits only eight pairs of cerebral nerves and thirty-four pairs of spinal nerves. Bichat makes three classes, the first com-

does not saponify; it also contains a small quantity of phosphorus. (Tiedemann, G. R. Treviranus, and L. C. Treviranus, *Zeitschrift für die Physiologie*, part i. 1824, p. 119). F. T.

* We have every reason to think that this apoplexy is an effect of arachnoiditis. F. T.

† This *apoplexia sine materia*, is exactly that which presents so frequent instances of softening of the brain. We may add to the three varieties mentioned by the author, the *apoplexia convulsiva* of some pathologists, which seems to be an inflammation of the encephalon, attended more or less promptly with a comatose state and with paralysis. F. T.

prising two nerves of the cerebrum, the second six of the mesocephalon, and the third thirty-four spinal nerves. Others with Portal, tacitly admit another intermediate class in which the accessory nerve is placed, which in the general method belongs to that of the cerebral nerves. Others, as Sabatier, Bichat, and Cloquet, following Willis, exclude the first nerves of the spinal marrow from the number of spinal pairs, and consider them as the most inferior cerebral nerves.

This last method is the least natural of all, for although the upper pair of the spinal nerves is often between the cerebral and spinal nerves in character, as may be seen from the description, still it is more like the latter than the former. The want of exactness in considering the last four cerebral nerves as the first spinal pairs, is also proved by the contradiction between the general characters of these four nerves and those of the spinal marrow, and it then becomes impossible to generalise about these last. This classification is farther very inconvenient, since a slight examination demonstrates that certain nerves (for instance, the auditory and external motor nerves) arise from the same region of the central part of the nervous system: and with a little care and patience this may be proved of most of the others. The same reasons which impelled us to separate the medulla oblongata from the spinal marrow, and to consider it as a portion of the encephalon, have obliged us to place the nerves derived from it among the cerebral. The characters of these nerves, which resemble those of the cerebral rather than those of the spinal nerves, demonstrate also the superiority of our method.

We shall first examine the spinal nerves, not only because we have already treated of the spinal marrow when describing the cervicle part of the nervous system, but because from the cerebral nerves, which will be mentioned last, we shall naturally pass to the organs of sense, and from them to the more complex organs, with which we shall close the treatise.

CHAPTER I.

NERVES OF THE SPINAL MARROW.

§ 1810. We have already mentioned the general characters of the *nerves of the spinal marrow*:* they are divided into as many sections as there are regions in the vertebral column, consequently into *cervical, thoracic, lumbar*, and *sacral nerves*.

We shall first describe the thoracic nerves, except the first one, because they are more simple and arise the first, next the nerves of

* J. J. Huber, *De medullâ spinali, speciatim de nervis ab eâ provinientibus*, Gottingen, 1741.—G. Frotscher, *De medullâ spinali ejusque nervis*, Erlangen, 1788.

the limbs, those of the inferior extremities arising from most of the sacral and lumbar nerves, those of the superior from the first dorsal and the last four cervical; finally, the four superior cervical nerves, which lead by a remarkable transition to the cerebral nerves.

Before describing minutely the nerves of these different regions, we ought to make known the following characters which belong to them in common, and which are important in regard to their topography.

1st. There is no constant difference between the nerves of the right and those of the left sides.

2d. The nerves are not perfectly symmetrical; one is often situated higher than another, and the number of cords is frequently greater by two or three on one side than on the other. But this difference is almost always compensated for, because then the adjacent pairs vary in the opposite manner.

3d. The upper and lower pairs are much nearer each other than the central. The latter also after the last dorsal nerve, are so near each other that they do not seem like separate nerves. They are also much nearer in the early periods of existence, and even during the first years of life than at subsequent periods. This propinquity in the superior and inferior regions, is owing to the disproportion between the size of the nerves and the shortness of that part of the spinal marrow from whence they arise. Hence why the smaller thoracic nerves, which arise not much above the place from whence they leave the spinal marrow, are farther from each other, and the reason of the greater distance between the spinal nerves in animals whose necks are longer, and in whom too the spinal marrow descends lower than in man.

4th. The ganglions formed by the posterior roots are situated in the intervertebral foramina, except those of the sacral nerves which are found in the cavity of the sacrum.

These ganglions are not all of the same size in all regions, and their development is not in a direct ratio with that of the nerves. In fact, a ganglion which is usually large, is not unfrequently replaced by another very small, and *vice versa*. The ganglions of the dorsal nerves are generally the largest, and those of the sacral nerves, especially the last, the smallest.

5th. All the spinal nerves divide soon after coming from the vertebral column into two branches, an anterior and a posterior, the first of which is often larger than the other, excepting always those of the second cervical nerve, which presents a contrary arrangement. The anterior branches turn first outward, then forward and inward, and terminate near or upon the anterior median line. The posterior go directly backward, and are distributed to the muscles which fill the groove between the spinous and transverse processes of the vertebræ, or in those which correspond to them in the cranium and the skin of this region. The first are distributed to the anterior muscles, which represent these dorsal muscles on the sides and anteriorly and in those of the extremities.

6th. All the spinal nerves communicate together very constantly by one or several larger or smaller branches which they give off soon after leaving the vertebral canal, and which anastomose with those analogous.

The anastomosing branches usually arise from the anterior part of the nerves, or belong only to their anterior branches, and go before the transverse processes on the sides of the bodies of the vertebræ. The brachial, lumbar, and sacral plexuses, are formed entirely in this manner; their arrangement, however, differs from that usually seen, being more complex, since the anastomosing branches produce others which anastomose several times with those near. Nerves composed of filaments from several trunks of different origins, arise from these points of union whether single or multiple.

One or more anastomosing branches communicate at the same time with the branches of the ganglionary system in the limiting ganglions.

Besides these anterior anastomosing branches which form along the vertebral column a series of plexuses, corresponding in number to that of the vertebræ, the posterior branches also anastomose in an analagous manner, especially at the upper region of the neck, although this arrangement is less general posteriorly than anteriorly.

ARTICLE FIRST.

DORSAL NERVES.

§ 1811. The *dorsal, thoracic, costal*, or *intercostal* nerves (*N. thoracici*, s. *dorsales*, s. *costales*, s. *intercostales*) are, like the dorsal vertebræ, twelve in number. Some anatomists, however, as Haller,* count only eleven, and annex to the lumbar nerves that usually regarded as the twelfth. We shall examine only the eleven inferior nerves, as it is more convenient to describe the first with the four inferior cervical nerves.

The general characters of these nerves are as follow:—

1st. They make part of the smaller nerves of the spinal marrow, and are particularly smaller than the inferior cervical, the lumbar and the superior sacral nerves.

2d. Most of them, especially the inferior, are those spinal nerves which arise farthest from each other. Still the superior are nearer to each other than the superior cervical nerves are.

3d. Most of them communicate only by intermediate filaments in the vertebral canal. Still we have often found between the first and second pairs, as between the second and third, a filament, proceeding obliquely from above downward and from within outward, from the

* *El. phys.*, lib. x. not. 38.

superior edge of the inferior nerve to the inferior edge of the nerve situated immediately above. They have always seemed smaller between the second and third pair than between the first and second.

4th. Their trunk furnishes on emerging, and immediately after, some thin short branches which go forward and enter either into the nearest limiting ganglion of the ganglionary nerve, or more rarely into the filament of communication between two of these adjacent ganglions. It then divides soon after emerging into two branches, one *anterior*, *intercostal*, or *subcostal* (*R. intercostalis*, s. *subcostalis*), the other *posterior* or *dorsal* (*R. dorsalis*).

The anterior branch proceeds under the rib, below which the trunk comes from the vertebral canal, between the external and internal intercostales muscles, and advances as far as these last extend. It accompanies the intercostal vessels lodged more or less immediately in the groove of the rib. In its course it gradually leaves the superior rib, so that its anterior part is nearer the rib below than that above. It then perforates the intercostales muscles near the sternum, and becomes external Proceeding, it gives branches to these muscles, the upper part of the abdominal muscles, and to the skin which covers the intercostales muscles. These last filaments called the *external thoracic* nerves (*R. pectorales externi*) succesively perforate the intercostales muscles from behind forward, but all arise very far from the place where they emerge.

Each anterior branch near its origin sends off posteriorly several branches, of which the *internal* are usually numerous, and go, independently of those coming from the trunk, to the limiting ganglions of the ganglionary nerve and their filaments of union, and anastomose in this place with the analagous branches of the adjacent dorsal nerves while the *external*, which are simple, pass on the internal face of the ribs, and communicate with those of the two adjacent dorsal nerves, which go to meet them. These last are sometimes deficient in the middle pairs: but their absence is not always observed, as they not unfrequently occur there, although they are more developed in the upper and lower pairs.

The posterior branch proceeds backward between the transverse processes of the vertebræ, between which it arises under the multifidus spinæ muscle, and there usually divides into external and internal branches, the latter of which are smaller and are deficient when the division does not take place.

The *internal* branches are distributed to the multifidus spinæ, the semispinalis, the spinalis, the internal belly of the sacro-lumbalis, the digastricus nuchæ, the complexi, the transversalis, the inferior portion of the splenius, the rhomboidei, the trapezius, and the latissimus dorsi muscles.

The *external* branches proceed outwardly, emerge between the scalenus muscle and the internal belly of the sacro-spinalis, and in this place penetrate between the two bellies of the latter muscle, to which they are distributed, and also to the superficial muscles of the back.

Besides, these two branches usually, but not always, extend to the skin.

All the dorsal nerves are not of the same size. Except the first, which is the largest, they go on increasing in size much from the second to the last. However they do not enlarge uniformly; Haller* and Sœmmerring have observed, and the results of our numerous dissections also coincide with their opinion, that the fourth, sixth, and eighth are smaller than the fifth, seventh, and ninth.

§ 1812. The differences in the distribution of the thoracic nerves, depend principally on their anterior or intercostal branches.

The first is remarkably distinguished from the others. It soon goes upward and outward above the first rib, toward the brachial plexus, and opposite to this rib divides into two branches. One which is proportionally very small, goes forward and proceeds below the first rib, like the anterior branches of the other thoracic nerves. The second is much larger, and ascends and corresponds to the small anastomosing branches of the other thoracic nerves; it immediately unites with the brachial plexus, with which we shall describe its farther progress.

The anterior branches of the second and third thoracic nerve, together furnish to the skin of the arm an inferior branch, which may be called the *brachial* nerve. Both then send some filaments to the intercostales muscles, penetrate the external, then descend to the teguments at the axilla and unite, but not always uniformly, with the internal cutaneous nerve of the arm, and expand in the superior and internal part of the teguments of the arm, so that their filaments, especially those of the second pair, descend to the elbow.

Anteriorly, the anterior branches of these two nerves terminate in the anterior part of the pectoralis major and the triangularis sterni muscle. In their passage they furnish no constant branches to the abdominal muscles.

The anterior extremities of the anterior branches, and of the second, third, fourth, fifth, sixth, and seventh thoracic nerves, are distributed also in these two muscles, the skin of this region, and the thymus gland. The external pectoral twigs of these branches penetrate into the upper part of the obliquus externus and rectus abdominis muscles, also in the skin which covers them.

The anterior extremities of the anterior branches of the eighth ninth, tenth, and eleventh thoracic pairs, pass above the costal digitations of the diaphragm, glide between the obliquus internus and transversalis abdominis muscles, distribute filaments to these muscles, and then go to the posterior face of the rectus muscle and to the skin which covers it.

The external pectoral twigs of these branches are distributed in the upper part of the obliquus abdominis internus muscle and the skin near it.

* *De part. corp. hum.*, vol. viii. p. 399.

The eleventh thoracic nerve gives filaments to the posterior part of the diaphragm.

The twelfth, described by Haller as the first lumbar nerve, anastomoses by a large branch with the first lumbar pair, and sends filaments to the diaphragm, then passes before the superior part of the quadratus lumborum muscle, between it and the posterior tendon of the transversalis, gives off filaments and divides at its external edge into superficial and deep abdominal branches. The former pass between the transversalis and obliquus internus abdominis muscles, and terminate there, and also in the lower part of the rectus and pyramidalis muscles. The second go between the two oblique muscles, pass through the external, and are distributed to the integuments of the abdomen as far as the ossa ilia.

ARTICLE SECOND.

LUMBAR AND SACRAL NERVES.

§ 1813. The description of the *lumbar* and *sacral** nerves ought to follow that of the thoracic, because by then describing the cervical, we proceed from below upward to the explanation of the encephalic nerves. We shall combine our observations in regard to these two orders of spinal nerves, because they resemble each other in their most essential characters, and particularly as they unite to form the nerves of the inferior extremities.

The five lumber nerves and the sacral nerves, which are also five and sometimes six in number, arise near each other from the inferior prominence of the spinal marrow. They emerge from the medullary canal, the lumbar passing out through the intervertebral foramina, situated between the lumbar vertebræ as between the last one and the upper surface of the sacrum. The sacral nerves form the sacral foramina, except the last, which passes between the sacrum and the first piece of the coccyx. Not only the anterior and posterior roots of each pair, but the different pairs themselves are closely united to each other from their origin to the ganglions formed by their posterior branches; but neither the first nor second communicate by intermediate filaments. The sacral nerves differ from all other spinal nerves by the situation of their ganglions, which do not anastomose when coming from the nerve, but in the channel of the vertebral column, and are as much more distant from the sacral foramina the lower the origins of the nerves to which they belong, so that the anterior and posterior roots of these last unite even within the medullary canal. The trunks resulting from their union divide near their origin, and also within the vertebral canal, into anterior and posterior

* J. L. Fischer, *Descriptio anatomica nervorum lumbalium, sacralium et extremitatum inferiorum*, Leipsic, 1791.

branches, which do not usually anastomose together in this canal, but emerge, the first through the anterior sacral foramina, the others through the posterior sacral foramina. The union of the anterior and posterior roots of the sacral nerves in the medullary canal, undoubtedly corresponds to the fusion of the false sacral vertebræ in a single bone, and it takes place after the same type so evident in the vascular system. Perhaps, also, it partially depends on the greater distance between the point from whence the nerves originate, and that whence they emerge. One circumstance favours this conjecture, viz. that the place where the posterior and anterior roots unite, is farther in the inferior nerves where the trunk is proportionally longer. But this circumstance also favours the opinion first proposed, since the inferior false sacral vertebræ unite also sooner than the superior.

The anterior branches of these ten nerves, which enlarge very much, form a plexus which may be called the *femoral* or *crural plexus*, (*plexus femoralis*). This plexus, like the brachial and cervical, is produced by the increase and multiplication of the anastomoses between the anterior branches, which is in proportion to the increase of volume of the nerves, and which takes place in breadth, and from without inward, and in thickness or from behind forward.

We may consider separately the superior and inferior parts of this plexus, the first as the *lumbar* or *lumbo-abdominal* plexus*, the second as the *sacral* or *sciatic plexus*, since from each of these two parts, which are formed, the first by the lumbar, the second by the sacral nerves, arise nerves which are distributed differently. Still as the principal nerves which come from it are all distributed to the lower extremities, it is more convenient to regard them as forming one plexus only, as the inferior lumbar nerves mostly form the sacral plexus and the nerves which come from it.

This plexus is indicated in the dorsal region by the much smaller anastomosis between the anterior branches, and which are constantly developed in the inferior thoracic pairs.

Of the nerves which form it, the upper suddenly enlarge very much from above downward, and the lower from below upward.

The last two sacral nerves are the smallest, and the last especially is the smallest of all the spinal nerves. Next comes the first lumbar, then the third sacral; the second lumbar is a little larger, being about the same size as the second sacral; the third and fourth lumbar which are almost equal, are a little larger than the preceding. The fifth lumbar and the first sacral are much the largest.

Dorsal branches which are much smaller arise from all these nerves which unite to form the crural plexus, commencing before the union of their anterior branches, when they emerge from the foramina: these go directly backward between the transverse processes of the lumbar vertebræ and the sacrum, passing there through the posterior sacral

* J. A. Schmidt, *De plexu lumbali, de nervis lumbalibus eorumque plexu commentarius anatomico-pathologicus*, Vienna, 1794.

foramina. These branches are distributed to the posterior part of the muscles of the back, to the gluteus maximus and the skin which covers them.

The *posterior* branches, the *dorsal* or *lumbar* (*R. postici*, s. *dorsales*, s. *lumbales*), of the lumbar nerves diminish considerably in volume from the first to the last, so that the last two rarely extend to the skin, but are distributed only in the common belly of the sacro-lumbalis and multifidus spinæ muscles. From the first sacral nerve to the fourth, the posterior branches again enlarge much. That of the fourth is the largest; the fifth is smaller, while the sixth is much more minute.

§ 1814. The *anterior* or *abdominal* branches (*R. antici*, s. *abdominales*) of the lumbar nerves pass behind the psoas magnus muscle, unite not only with each other, but beside the first with the anterior branch of the last dorsal, the last with the anterior branch of the first sacral, to form the lumbar plexus, the lumbar ganglion of the ganglionary nerve, and produce the nerves we are about to describe. The anterior branches of the sacral nerves, principally the first, second, third, and fourth, concur in the same manner to form the sacral plexus to which the fifth contributes least, and the sixth takes no part when it exists.

Some ramifications arise from the anterior twigs after their union, some of which, the smaller ones, are usually formed by the filaments of a single nerve, while others which are larger, arise from the union of fasciculi from several nerves.

The first are principally the external pudic nerve, several branches for the muscles in the lumbar region, the skin of this region, and the common integuments of the inguinal region, the gluteal nerves and the inferior and middle hemorrhoidal nerves.

The second are the three nerves of the lower extremities, the obturator, the crural, and the gluteal nerve.

A. SMALL NERVES WHICH ARISE FROM THE ANTERIOR BRANCHES OF THE LUMBAR AND SACRAL NERVES.

§ 1815. *First and second lumbar nerve.* From the first and second lumbar nerve, especially from the inferior extremity of the *plexus* between them, arise the *external pudic* or the *genitocrural* nerve (*N. pudendus externus*, s. *spermaticus externus*, s. *inguinalis*, s. *genito-cruralis*), which passes between the superior digitations of the psoas muscle, arrives at the anterior face of this muscle, on which it goes from behind forward and from above downward, and divides within the pelvis into branches which all emerge from the inguinal ring. Among these, the most considerable which are always the continuation of the trunk, arrive at the spermatic vessels, and are distributed in the male in the cremaster muscle and its coats, and in the female in the round ligament of the uterus, and anastomosing with the inferior pudic nerves, terminate in the glands and integuments of the inguinal regions The external passes under the crural arch, penetrates the aponeurosis,

is distributed in the skin to the middle of the internal face of the thigh, and anastomoses with some filaments of the crural nerve.

Besides there arise from the first lumber nerve and its anastomosis with the second, branches designed for the psoas, the quadratus lumborum, and the transversalis abdominis muscles and for the integuments of the lumbar and inguinal regions. One of these branches, which is large, penetrates the psoas muscle, goes forward between the obliquus internus and transversalis along the crest of the ilium, and terminates in the inferior part of the large abdominal muscles and skin of this region and of the scrotum.

Several filaments come from the *second lumbar* nerve, and are distributed to the psoas and quadratus lumborum muscles and the skin of the lumbar and inguinal regions: usually there arise one or two distinct branches which are longer (*nerfi lio-scrotal,* Ch.), which passing through the psoas muscle, proceed outwardly before the quadratus lumborum, penetrate the transversalis, then the obliquus internus, to which they give filaments, go forward along the crest of the ilium, perforate the aponeurosis of the obliquus externus, and are distributed to the skin of the inguinal region and scrotum.

3d. The *third lumbar* nerve usually gives off a cutaneous nerve which unites to the preceding one, or replaces it either partially or wholly, descends between the psoas and iliacus muscles, emerges from the pelvis, passing under the outward extremity of the crural arch, and is distributed to the external and anterior extremities of the integuments of the thigh to the neighbourhood of the knee. There it is the *inferior branch* of the *crural* plexus of Bichat, the *inguino-cutané* of Chaussier.

4th. The *fourth lumbar* nerve usually gives branches only to the iliacus muscle.

5th. The anterior branches of the fourth and fifth lumbar nerve unite to form a very considerable trunk, the *lumbo-sacral* nerve of Bichat (*N. lumbo sacralis*), which is much larger than the crural, and give origin in the very cavity of the small pelvis, but always before uniting with the first sacral nerve, to the *superior gluteal* nerve (*N. glutæus superior*), which emerges from the pelvis below the upper edge of the sciatic notch, is distributed to the gluteus medius and minimus, and penetrates even forward to the tensor vaginæ femoris.

6th. From the *second* and *third sacral* nerve, come some fasciculi, which unite, then give filaments to the pyramidalis muscle, and coming from the pelvis below it, go to form the inferior gluteal nerve.

Before these fasciculi, a very considerable nerve arises from these same nerves farther below and forward, sometimes also from the fourth sacral nerve, called the *external common hemorrhoidal* nerve (*N. pudendo-hæmorrhoidalis communis externus*), which re-enters into the pelvis, between the two sacro sciatic ligaments, and divides into two branches, the *external pudic*, and the *inferior hemorrhoidal* nerve.

The *external* or *superior pudic* nerve, *ischio-pénien* or *ischio-clitoridien*, Ch. (*N. pudendus externus*, s. *superior*) goes along the ascending

branch of the ischium and the descending branch of the pubis, proceeding on gives branches to the obturator internus and bulbo-cavernosus muscles, then passes under the symphysis pubis to go forward, as the *dorsal nerve of the penis* (*N. dorsalis penis*) in the male, and that of the *nerve of the clitoris* (*N. clitorideus*, s. *pudendus superior*) in the female, proceeds along the penis and clitoris, sends filaments to the skin which covers them, and also to the mons veneris and mucous membrane of the urethra, and terminates finally in the glans.

The *inferior hemorrhoidal* nerve, called also the *inferior pudic* (*N. hæmorrhoideus*, s. *pudendus inferior*), partly accompanies the preceding, then goes upward between the bulbo- and ischio-cavernosus muscle, is distributed to the integuments and in all the muscles of the perineum to the inferior extremity of the rectum, the skin of the scrotum and mucous membrane of the urethra, and anastomoses with the external pudic, the inguinal and internal hemorrhoidal nerves.

From the difference in size between the penis and clitoris, the external pudic is the larger of these two branches in the male, while the internal hemorrhoidal is the larger in the female.

7th. The *third* and the *fourth sacral* nerves also give off the *middle hemorrhoidal* nerves (*N. hæmorrhoidales medii*), which are smaller, and not united at their origin; but this term is not exact, for they are distributed partly to the rectum, the levator and sphincter ani muscles, and proceed on the side of this intestine to be distributed from below upward in the walls of the bladder, at the commencement of the urethra, uterus, and vagina, the prostate gland and vesiculæ seminales in the male, and frequently anastomose with the lower part of the great sympathetic nerve to give origin to the hypogastric plexus.

8th. The *fifth* and *sixth lumbar* nerves, when they exist, are in fact connected with the crural plexus, but do not contribute to form the nerves which come from them. Their anterior branches are distributed to the sacro-coccygeal, the levator, and sphincter ani muscles. Their posterior are distributed in the integuments of the posterior part of the anus and perineum.

B. LARGE NERVES WHICH ARISE FROM THE ANTERIOR BRANCHES OF THE LUMBAR AND SACRAL NERVES, OR NERVES OF THE INFERIOR EXTREMITIES.

I. OBTURATOR NERVE.

§ 1816. The *obturator* nerve, *sous-pubio-fémoral*, Ch. (*N. obturatorius*),* the smallest of those belonging to this division, arises from the most anterior fasciculi of the second, third, and fourth lumbar nerves, rarely from the first, by an equal and sometimes greater

* See in regard to this and the following nerve, M. C. Styx, *Descript. anat. nervi cruralis et obturatorii*, Jena 1782.

number of roots, which meet at acute angles. It descends into the lower pelvis, before the following nerve, is covered by the psoas muscle, goes forward along the linea innominata, accompanied by the vessels of the same name, comes out through the obturator foramen, and divides into two branches, an anterior superficial and large and a posterior deeper and smaller.

The anterior branch is distributed to the gracilis, the adductor longus, and brevis muscles, and sends to the internal saphena nerve some branches which are sometimes so large that this last seems to arise from it rather than from the crural.

The posterior branch is distributed in the obturator muscles, particularly the externus, and in the adductor magnus muscle, even descending to near its inferior extremity.

II. CRURAL NERVE.

§ 1817. The *crural* nerve, *fémoro-prétibial*, Ch. (*N. cruralis*), is larger than the preceding, behind which it is situated, arises from the posterior part of the first, second, third and fourth lumbar nerves, descends along the posterior and external side of the crural artery, between the psoas and iliacus muscles, gives several branches to these two muscles, but principally to the second, and furnishes one considerable which sometimes comes off higher than the branches destined to the iliacus muscle, anastomoses near the crural arch with another branch which arises in this place, comes sometimes also from the fourth lumbar nerve, and then is distributed in the integuments of the anterior and internal face of the thigh. This branch is called the *superior* or the *small saphena* nerve (*N. saphenus superior*, s. *minor*).

A branch is generally given off a little below the crural arch which proceeds from within outward, and goes to the common lower extremity of the iliacus and psoas muscles.

The nerve then divides generally below the crural arch into two branches, an external larger, and an internal smaller, above.

The external branch also soon divides into several twigs, which go to the four heads of the extensor of the leg, to the cruræus, and to the tensor vaginæ femoris muscle. These branches descend to the articulation of the knee and penetrate into its capsule.

The internal branch gives to the sartorius muscle many twigs, most of which enter its middle and inferior part. It gives them also to the skin of the internal face of the thigh. But the largest of all the branches which come from it is the *internal saphena* nerve, *tibio-cutané*, *Ch.* (*N. saphenus internus*). This nerve accompanies the internal saphena vein, which it surrounds at several different parts, distributes some filaments to the integuments of this region, descends on the back of the foot, and extends even to the great toe.

III. SCIATIC NERVE.

§ 1818. The *sciatic nerve, grand femoro-poplité*, Ch. (*N. ischiadicus*),* the largest of all the nerves, not only of the inferior members, but even of the whole body, arises from the inferior half of the fourth lumbar nerve, and from all the fifth, also from the three superior sacral; the anterior branches unite to form the sciatic or sacral plexus (*plexus sacralis*, s. *ischiadicus*), which is only the inferior part of the crural plexus, although we usually consider this the only plexus of nerves of the lower extremities.

§ 1819. The sciatic nerve sometimes, partially or wholly, gives off the *superior gluteal* nerve, and always the *inferior* either wholly or partially. This last emerges sometimes above and sometimes below the pyramidalis muscle, anastomoses with a branch of the sciatic nerve which arises a little lower, and is distributed with it in the gluteus maximus muscle.

§ 1820. The sciatic nerve emerges from the sacral plexus through the sciatic notch, between the pyramidalis and gemelli muscles.

There it sends to the obturator internus a considerable branch, which penetrates from without inward between the large and small sciatic ligaments, and enters from below upward into this muscle.

Then it gives a second, which descends before the gemelli and the tendon of the obturator internus, distributes filaments to the first two of these muscles, and is distributed in the quadratus femoris muscle.

Still lower a large branch leaves its posterior part, and unites to the inferior gluteal nerve (§ 1788), with which it goes to the gluteus maximus muscle.

The trunk first gives branches to the flexor muscles of the thigh; then to the long head of the biceps; then to the semitendinosus; farther on, to the semimembranosus muscle; finally, to the short head of the biceps. The filament of the semimembranosus is distributed also to the adductor magnus muscle.

Farther on it gives off the *middle posterior cutaneous* nerve (*N. cutaneus posterior medius*), which descends under the skin of the posterior face of the thigh and leg to the calf, and anastomoses with some filaments of the superior and inferior nerves.

The *inferior posterior cutaneous* nerve, (*N. cutaneus posterior inferior*) is given off below this branch; it proceeds in part like the former one, and is partially expanded in the posterior part of the capsular ligament of the knee.

§ 1821. The sciatic nerve then divides into two branches: the internal, the larger, is the *tibial* nerve, and the external, the smaller, the *peroneal* nerve. This division usually takes place at the middle of the thigh, often higher up, and even above the sciatic tuberosity, so that the two branches are separated from each other by the pyramidalis muscle.

* J. H. Joerdens, *Descriptio nervi ischiadici*, Erlangen, 1788.

When the bifurcation occurs higher than usual, it is analogous to the arrangement of the sciatic nerve in the mammalia.

Rosenmuller mentions a national difference in regard to the height of this division, viz. that the sciatic nerves divide very high in the inhabitants of the north of Europe, while in those of the south it bifurcates very low not far from the ham.* We have not observed this difference.

When the nerve divides high, the two branches are separated by the pyramidalis muscle, and they descend, the external behind, the internal before it.

The *popliteal* nerve (*N. popliteus*) rarely or never exists.† At most the name of the *internal* and the *external popliteal* nerve may be given to the upper part of the two terminating branches of the sciatic nerve, from their origin to the femoro-tibial articulation.

a. Peroneal nerve.

§ 1822. The *peroneal* or *external popliteal* nerve (*N. peroneus*) often gives origin to the posterior, inferior, and middle cutaneous nerves. It descends from within outward on the internal side of the biceps femoris muscle, passes between the extensor longus digitorum communis and peroneus longus muscles, sends filaments to these muscles, and likewise to the tibialis anticus, and divides very high up into two branches, the *superficial* and the *deep peroneal* nerves.

§ 1823. The *superficial peroneal*, or the *muscular cutaneous* nerve, *prétibio-digital*, Ch. (*N. peroneus superficialis*), soon divides into two branches, an external superficial and small, the other internal, which is deeper and larger.

The first, or the *cutaneous peroneal* nerve, which might more properly be called the *middle cutaneous nerve of the back of the foot*, or the *external branch of the peroneal* nerve (*N. cutaneus peroneus*, s. *cutaneus medius dorsi pedis*, s. *cutaneus peroneus externus*), descends on the peroneus brevis muscle, passes on the crucial ligaments of the tarsus, is distributed to the skin of the external part of the back of the foot, and terminates by filaments which are the *tibial nerve of the little toe*, the *dorsal nerves of the fourth toe*, and the *peroneal nerve of the third toe*.

The second, the *anterior nerve of the back of the foot* (*N. dorsi pedis anticus communis*, s. *peroneus anticus*, s. *pedalis anticus*), is situated before the former, also near the surface, and is distributed partly to the internal half of the back of the foot, partly to the skin of the external and anterior faces of the leg, and terminates by producing the dorsal nerves of the two external toes and the peroneal nerve of the third.

§ 1824. The *deep peroneal* or *anterior tibial* nerve, *prétibio-sus-plantaire*, Ch. (*N. peroneus profundus*), descends deeply between the

* In *Neer Journal der Erfindungen in der Natur-und Arzneywissenschaft*, part ii., p. 100.

† Coopmans has made the remark (*Neurol.*, ed. 2, p. 198).

nuscles on the anterior face of the tibia, at the side of the anterior ibial artery, but does not pass with it from the posterior to the anterior ace of the leg, between the two bones, for the whole trunk of the peroneal nerve is situated and divides on the external face of the fibula.

Such at least is always the arrangement of the deep peroneal ierve according to our observations. Although we have made many careful dissections, yet we have never seen it pursue the course of the interior tibial artery. Thus, although this authority is sanctioned by a great name,* it certainly is not the usual arrangement, and should be considered as a very rare anomaly, more especially as many writers, Coopmans † among others, do not sanction it, or speak only of the first.

This nerve gives filaments to the peroneus longus, and to the xtensor longus digitorum communis muscle, to the tibialis anticus, nd to the extensor hallucis proprius, passes under the crucial ligament of the tarsus, and arrives on the back of the foot, where it terminates in the extensor digitorum brevis, the first interosseous muscle, nd the internal part of the skin of this region, by anastomosing with ome branches of the cutaneous nerve around the foot, so that the orsal nerves of the large toe more properly arise from this than from he latter.

We have always found the peroneal nerve distributed in this manner, but we have never found that of the two branches into which . divides at the upper extremity of the fibula, one was the external utaneous nerve, the other, the common trunk of the anterior tibial nd internal cutaneous nerves ;‡ Sabatier,§ Coopmans,|| and Reil,¶ tate the same distribution as ourselves: this arrangement then hould be regarded as the most constant.

b. Tibial nerve.

§ 1825. The *tibial* or *internal popliteal* nerve (*N. tibialis*), the argest and most internal of the two terminating branches of the sciatic erve, may be called the *popliteal* (*N. popliteus*), from the bifurcation the calf of the leg, although this term is not perfectly exact. It gives f first a considerable cutaneous nerve, the *long posterior cutaneous erve of the foot and the leg*, or rather the *external cutaneous tibial erve of the foot* (*N. cutaneus longus posterior tibiæ, s. cutaneus pedis ternus, s. tibialis*), which nevertheless often comes from the peroneal erve, or at least especially when the sciatic nerve bifurcates high up, partially replaced either by the posterior and inferior branch of this tter, or even by its inferior and middle cutaneous nerve.

* Sœmmerring, *Hirn-und Nervenlehre*, p. 312.
† *Neurologia*, p. 203.
‡ Sœmmerring, *Nervenlehre*, p. 309.
§ *Tr. complet. d'anat.* ed. 3. vol. iii. p. 328.
|| *Neurologia*, pp. 201—203.
¶ *Anat. descript.*, vol. iii, p. 309.

The external cutaneous tibial nerve of the foot descends behind the muscles of the foot, goes outward below the external malleolus, proceeds along the external edge of the foot and the fibular edge of the fifth toe, constituting its dorsal peroneal nerve, and proceeds to the top of it.

The tibial nerve then gives off a small branch to the posterior part of the capsule of the articulation of the knee. This branch is sometimes given off higher, or as high as the preceding.

Farther on, the trunk of the tibial nerve gives external and internal branches to the three heads of the triceps, the plantaris, the popliteus, the tibialis posticus, and the flexor hallucis longus.

§ 1826. The tibial nerve then goes forward between the upper two heads of the triceps suræ muscle, descends between the tendo achillis, the tibialis posticus and the flexor hallucis longus, passes behind the malleolus internus, and goes to the sole of the foot.

Behind the malleolus it divides into three branches, one superficial and two deep.

§ 1827. The superficial branch or the *external tibial* nerve (*N. tibialis exterior*), more properly the *proper cutaneous plantar* nerve (*N. cutaneus plantaris proprius*), is distributed to the skin below the malleolus internus, and at the posterior part of the sole of the foot.

§ 1828. The two deep branches are the *internal* and the *external plantar* nerve.

The *internal plantar* nerve (*N. plantaris internus*) is usually a little larger and more superficial than the other; it goes forward under the long head of the adductor hallucis, between it and the flexor communis digitorum brevis, and divides far back into two branches, an internal and an external: the latter is the larger.

The internal branch having given filaments to the adductor hallucis, becomes the *first plantar nerve of the toes* (*N. digitorum plantaris primus*), the *tibio-plantar* nerve or the *internal nerve of the great toe* (*N. plantaris internus, s. tibialis hallucis*).

The external branch also subdivides into two others, the external of which is also the larger.

The internal, or the *third plantar nerve of the toes*, also divides into the *external plantar nerve of the second toe*, and the *internal plantar nerve of the third toe*.

The external, or the *fourth plantar nerve of the toes*, divides into the *external plantar nerve of the third toe*, and the *internal plantar nerve of the fourth*.

Thus this trunk distributes its branches to the internal half of the skin of the foot, to the two sides of the three internal toes, and to the internal side of the fourth.

§ 1829. The *external plantar* nerve (*N. plantaris externus*) goes forward and outward between the flexor communis digitorum brevis, and the tendon of the flexor longus, and divides before the tuberosity of the calcaneum into three branches.

The internal branch, the *fifth plantar nerve of the toes*, which is entirely cutaneous, goes forward to the anterior extremity of the tarsus, where it divides into the *plantar nerve of the fourth toe*, and the *internal plantar nerve of the fifth.*

The external branch, the *musculo-cutaneous* nerve, goes forward along the fibular edge of the sole of the foot, gives filaments to the abductor minimi digiti muscle, and becoming the *external plantar nerve of the fifth toe*, advances to its extremity, where as in the great toe, it receives at its external edge a distinct branch, an arrangement which is worthy of notice, as it contributes to the lateral symmetry. This nerve forms the *sixth plantar nerve of the toes.*

The middle, deep, or muscular trunk is the largest. It goes obliquely inward and forward, penetrates between the tendons of the extensor longus digitorum communis and the deep muscles of the sole of the foot, and distributes itself in the lumbricales, the adductor and flexor hallucis muscles, and in almost all the internal part of the interossei muscles, and the small muscles of the fifth toe.

ARTICLE THIRD.

OF THE CERVICAL NERVES.

§ 1830. Till the time of Willis, eight *cervical* nerves, *tracheliens* Ch. (*N. cervicales*, s. *N. colli*) * were admitted, but this anatomist and many after him, have mentioned only seven ; as they consider the first cervical as the last encephalic nerve, an opinion less correct than the ancient. The general characters of these eight nerves are—

1st. Of all the spinal nerves they have the least extent in the vertebral column from their origin to the place where they penetrate the dura-mater, and emerge through the intervertebral foramina.

2d. The internal extremities of their roots are closer to each other than those of the thoracic nerves, but farther than those of the lumbar and sacral nerves.

3d. The different pairs are united together by anastomoses ; these are usually simple, and extend from the inferior edge of the root of the superior nerve, to the upper edge of that of the lower nerve, and form the upper part of this last. The anastomosing filaments of the posterior roots are more constant than those of the anterior ; the latter usually exist only between the second and third pairs, and the third and fourth, and are deficient between all the others. On the contrary, the anastomosing filaments of the anterior roots exist in almost every part, but are sometimes deficient between the lower pairs. They are very seldom met with between the last cervical and the first dorsal nerve. We, however, should observe that the anastomosing filaments often do not exist between the middle cervical pairs, although found between the superior and the inferior nerves.

* J Bang, *Nervorum cervicalium anatome*; in Ludwig, Sc. neur.

The arrangement of these filaments is not always exactly the same; we usually see a filament which goes a little obliquely upward and outward from the internal extremity of the upper edge of the lower nerve, towards the external extremity of the lower edge of the upper nerve. But sometimes this filament descends directly from the lower edge of the upper nerve, to the upper edge of the lower nerve.

Between this arrangement and the preceding is one which is intermediate, where the most superior fasciculus of the lower nerve divides at its centre into two parts, the upper of which goes to the upper nerve in the first of the two modes mentioned above, while the lower proceeds in the direction of the fasciculus, forming the most upper part of the lower nerve. Sometimes one or two thin fasciculi are found between two pairs of nerves, and usually a little nearer the lower than the upper. When there is only one fasciculus, this divides into two; when two, they arise immediately one at the side of the other. In both cases either the fasciculi primitively distinct, or the two branches of the single fasciculus separate from below upward immediately after arising, and form, one the most inferior fasciculus, the other the most superior of the pairs between which they are situated. Sometimes they are united together by superior and inferior fasciculi, and afterward by a transverse filament.

The first arrangement usually exists between the inferior cervical nerves, the third between the middle, the second between the superior, and the fourth between the first two, counting from above downward.

The cervical nerves may be divided into two groups; the first comprises the four lower pairs, the other the four upper pairs, for the first differ much from the second, as they enlarge to give origin to the nerves of the upper extremities.

A. INFERIOR CERVICAL NERVES AND FIRST DORSAL NERVE, OR NERVES OF THE UPPER EXTREMITIES.

§ 1831. The *nerves of the upper extremities* (*N. brachiales*, s. *extremitatis superioris*)* arise from the first dorsal and the four inferior cervical nerves, which unite at some distance from their foramina to form the brachial plexus, so that a greater number of trunks comes afterward from the latter, each of which is formed from the fasciculi coming from several of the carrying nerves. The first dorsal nerve emerges below the first dorsal vertebra, the eighth cervical below the seventh cervical vertebra, the seventh below the sixth, the sixth below the fifth, and the fifth below the fourth. That nerve which usually occupies the centre of the group, that is the seventh cervical nerve, is the largest; the first dorsal and the fifth cervical nerves are the smallest: the fifth cervical nerve is smaller than the first dorsal, and the sixth and eighth dorsal are about the same size.

* J. J. Klint, *De nervis brachii*, Gottingen, 1781.—P. Camper, *Demonst. anat. pathol.*, l. i. Amsterdam, 1760.

The nerves which usually emerge from the brachial plexus are the *thoracic*, the *scapular*, the *axillary*, the *radial*, the *external cutaneous*, the *median*, the *ulnar*, and the *internal cutaneous* nerves.

§ 1832. Before uniting, the five nerves which form the brachial plexus give off much smaller posterior branches, which go to the deep dorsal muscles of this region. The brachial nerves are then only the enlarged anterior branches of the superior dorsal and the four inferior cervical nerves.

§ 1833. These anterior branches descend from within outward, pass between the scalenus anticus and medius muscles, and soon unite to form the *brachial plexus* (*plexus brachialis*).* The two superior and two inferior usually unite before the middle with the adjacent branches.

The fifth and the sixth usually unite the first.

Two nerves arise from their union.

The superior after passing several inches, divides into two branches, one of which is the *axillary* or *circumflex* nerve, the other is large and unites with the large posterior fasciculi of the seventh and eighth cervical nerves to form the radial nerve.

The inferior, having proceeded two or three inches, unites with one or two anterior fasciculi of the seventh cervical nerve, and thus produces a more or less complicated plexus, whence the external cutaneous or the musculo-cutaneous nerve wholly, and the median partially, arise.

The seventh cervical nerve divides two or three inches from its emerging from the spinal canal into an anterior and a posterior branch, of which the second is larger.

The posterior branch blends with the upper posterior branch of the eighth cervical nerve in a small trunk, which soon joins the posterior branch of the trunk formed by the union of the fifth and sixth cervical nerves, and gives origin to the radial nerve.

From the anterior branch and the common trunk formed by the union of the fifth and sixth cervical nerves, several anterior thoracic nerves arise and then the musculo-cutaneous nerve; it gives rise with the eighth cervical and the first dorsal nerves to the median nerve.

The eighth cervical nerve divides into two branches, one posterior, thinner but longer, the other anterior, shorter but much thicker.

The posterior unites to some branches of the fifth, sixth, and seventh cervical nerves to form the radial nerve.

The anterior joins the first dorsal nerve.

The common trunk formed by this last union, divides into two branches, a superior and an inferior.

The superior, united with the fasciculi of the fifth, sixth, and seventh cervical nerves, becomes the median nerve.

The inferior forms the ulnar nerve.

The first dorsal nerve divides into two other branches, both of which unite with the eighth cervical nerve.

* Bang (*loc. cit.*) has figured the brachial plexus—Prochaska, *De struct. nerv.*, Vienna, 1779, tab. iv, v.—Scarpa, *Annot. anat.*, B. I. tab. f, 1.

The superior assists to produce the radial nerve.

The inferior concurs to form the ulnar nerve, and sometimes alone produces the internal cutaneous nerve.

I. THORACIC NERVES.

§ 1834. The *thoracic nerves*, *sterno-thoraciques*, Ch. (*N. thoracici*) may be distinguished into *posterior* and *anterior*.

The *posterior* arise from the branches of the fifth and sixth, sometimes also from the seventh cervical nerve, which are mostly united in a nerve which descends on the external face of the serratus major muscle, and is distributed in that muscle.

The *anterior* arise from the anterior trunk formed by the union of the fifth and sixth cervical nerves, and also from the anterior branch of the seventh and eighth, descend from behind forward, and give filaments to the subclavius, the pectoralis major and minor muscles, the thymous gland, and the skin of the anterior and superior part of the chest and shoulder, where they anastomose with some filaments of the fourth cervical and axillary nerves.

II. SCAPULAR NERVE.

§ 1835. The *scapular* nerve (*N. scapularis*), which is rather large, often comes from the fifth cervical nerve before it joins with the following. When it arises only after the union, it commences almost in the place where it is, passes through the coracoid notch of the scapula, arrives thus on the posterior face of the scapula, sends filaments to the supraspinatus muscle, goes downward over the neck of the scapula, and arrives at the infraspinal fossa, where it is distributed to the infraspinatus and teres minor muscles.

III. AXILLARY NERVE.

§ 1836. The *axillary* nerve, *scapulo-humeral*, Ch. (*N. axillaris*, s. *circumflexus brachii*), or more properly the circumflex nerve, arises from the posterior and superior branch coming from the division of the common trunk formed by the union of the fifth and sixth cervical nerves. It first sends branches to the infraspinatus muscle, which often receives a large one from the common trunk mentioned above, it then gives some to the teres minor and major muscles, then passing between these two muscles and the long head of the triceps extensor, it is reflected outward and backward on the head of the humerus, expands in the deltoides muscle, and finally becoming the *cutaneous nerve of the shoulder* (*N. cutaneus humeri*), together with the fourth cervical nerve, sends filaments to the integuments of this region.

IV. RADIAL NERVE.

§ 1837. The *radial* nerve, *radio-digital*, Ch. (*N. radialis*), is much larger than the preceding, arises from fasciculi of all the brachial nerves by three branches, which come one from the seventh cervical nerve only, the second from the fifth and sixth, and the third from the eighth cervical and the first dorsal nerves. Soon after its origin, it gives a large branch to the latissimus dorsi and filaments to the triceps extensor muscles. A little below the middle of the arm, it turns on the humerus, often re-appearing on its anterior face between the brachialis internus and the supinator longus muscles.

In turning on the humerus it gives a long and thin cutaneous branch, the *superior external cutaneous* nerve (*N. cutaneus externus superior*). This nerve descends along the radial edge and the inner face of the fore-arm, and interlaces with the cutaneous branch of the musculo-cutaneous nerve, extends a greater or less distance to the middle of the fore-arm, to the carpus, and even the thumb.

The trunk of the radial nerve then gives branches to the supinator longus, and the extensor carpi longus radialis muscles. It divides at the lower extremity of the fore-arm into two branches, a superficial or cutaneous and a deep or muscular.

The *superficial* branch (*R. superficialis dorsalis*, s. *cutaneus*) descends along the anterior edge of the radius between the supinator longus and the radiales muscles, arrives at the outer face of the fore-arm, passing below the tendons of the first of these three muscles, and divides usually some inches below the inferior extremity of the fore-arm into two almost equal branches, the anterior being a little the larger, which distribute filaments to the anterior region of the integuments of the back of the hand, and to the dorsal face of the three anterior fingers.

The *anterior* branch anastomoses in several places with those of the cutaneous branch of the musculo-cutaneous nerve, sends filaments to the skin of the radial side of the carpus and metacarpus, and divides on the carpus into two small branches, the *dorsal nerves of the thumb* (*N. cutanei pollicis dorsales*), which descend on its dorsal side along the radial and ulnar edges to its anterior extremity, furnish filaments to its dorsal face, and anastomose together and with the palmar nerves of the thumb.

The *posterior* branch usually divides soon after arising into two principal ramuscules, an anterior and posterior.

The anterior goes to the skin between the thumb and index finger, and arrived at the radial side of the last finger becomes the *radio-dorsal nerve of the index finger* (*N. dorsalis radialis indicus*).

The posterior soon subdivides into two filaments, one of which produces the *cubito-dorsal nerve of the index finger* and the *radio-dorsal nerve of the middle finger*, while the second is the *cubito-dorsal nerve of the middle finger*.

All these ramifications frequently anastomose with each other, or with those of the ulnar nerve, and thus give rise to a plexus called the *dorsal arch of the hand* (*rete*, s. *arcus dorsalis manus*).

The deeper or larger muscular branch gives off branches for the radialis brevis and the supinator brevis muscles; it then turns over these muscles and engages itself between their fibres, penetrates between the extensor digitarum communis muscle, arrives at the posterior surface of the fore-arm, gives off some large branches, some of which are recurrent to the extensor digitorum communis, to the extensor minimi digiti, and to the ulnaris internus and externus muscles. Then as the *external interosseous nerve* (*N. interosseous externus*), it descends on the extensor and the adductor pollicis longus muscles, to which it sends filaments, as also to the extensor indicis proprius muscle, and is finally lost in the capsule of the wrist-joint.

V. EXTERNAL CUTANEOUS NERVE.

§ 1838. The *external cutaneous* nerve, or *musculo-cutaneous* nerve, or the *perforating nerve of Casserius, radio-cutané*, Ch. (*N. cutaneus externus*, s. *musculo-cutaneus*, s. *perforans Casserii*), is much smaller than the preceding, although it descends almost as low as it. It arises from the fasciculi of the fifth, sixth, and seventh cervical nerves. It sometimes comes from the median nerve.

It frequently but not always penetrates the coraco-brachialis muscle. When this is not the case, it passes on the internal edge of this muscle, being joined to it only at its surface. It divides high up in the arm into two branches, the one muscular and small, the other cutaneous and larger.

The muscular branch gives filaments to the coraco-brachialis muscle, to the two heads of the biceps, and to the brachialis internus muscle.

The *cutaneous* branch passing between the biceps and the brachialis internus muscle, arrives at the anterior edge of the arm, descends on the radial side in the aponeurosis, accompanying the cephalic vein. It anastomoses frequently above with the external cutaneous nerve, and below with the dorsal branch of the radial nerve; it is distributed to the skin of the posterior surface of the fore-arm and the hand, and terminates at the thumb.

VI. MEDIAN NERVE.

§ 1839. The *median* nerve, *médio-digital*, Ch. (*N. medianus*), the largest nerve of the upper extremity, comes also from the brachial plexus. It descends on the inside of the arm near its lower extremity without giving off any branch, unless it be sometimes the external cutaneous nerve.

Some inches below the elbow-joint it gives several small muscular branches to the pronator teres, to the upper part of the radialis internus, the palmaris longus, and to the upper part of the flexor digitorum brevis muscles. Near the elbow it gives off a considerable branch, the *internal interosseus* nerve (*N. interosseus internus*), which descends before the flexor communis digitorum profundus, distributes branches to this muscle and to the flexor pollicis longus, is reflected on the anterior edge of the pronator quadratus, arrived thus at the posterior face of the fore-arm, it terminates in this muscle.

The trunk descends before the flexor digitorum profundus, between the bones of the fore-arm, gives off filaments to this muscle and to the palmaris longus, and gives a cutaneous branch which is distributed in the integuments of the palmar face of the carpus, where it anastomoses with the branches of the musculo-cutaneous nerve and the ulnar nerve. It then divides near the lower third of the fore-arm into two branches, an anterior or radial, and a posterior or ulnar; the first is the larger.

These branches descend, without giving any twig to the fore-arm, between the tendons of the flexors, with which they pass under the ligaments of the carpus, where they usually unite by some transverse fibres. At the palm of the hand they separate.

The radial branch divides at the carpus into an anterior and posterior twig.

The anterior very soon divides into three filaments, the *radio-palmar* and the *cubito-palmar nerves of the thumb*, and the *radio-palmar nerve of the index finger;* these frequently anastomose together, extend to the extremities of these two fingers, and terminate by considerable branches, and give filaments to the first lumbricalis muscle.

The posterior then sends a large branch to the adductor brevis, to its opponens muscle and the flexor pollicis brevis, after which it becomes the *cubito-palmar nerve of the index finger.*

§ 1840. The cubital branch divides at the commencement of the carpus into two twigs.

The anterior, which is smaller, sends filaments to the second lumbricalis muscle, and becomes the *radio-palmar nerve of the third finger.*

The posterior, which is larger, sends filaments to the integuments of the hand, soon divides into two ramuscules, the *cubito-palmar nerve of the third finger*, and the *radio-palmar nerve of the fourth.*

VII. ULNAR OR CUBITAL NERVE.

§ 1841. The *ulnar* nerve, *cubito-digital* (*N. ulnaris*, s. *cubitalis*), is a little smaller than the preceding, and arises from the three inferior nerves of the brachial plexus. It descends inward and backward, gives off no branches along the arm except sometimes the internal cutaneous

nerve, and arrives at the ulnar side of the fore-arm, passing immediately behind the internal condyle of the humerus, where it may be easily compressed.

Arrived at the fore-arm, it first gives off ramifications to the flexor digitorum profundus and to the flexor carpi ulnaris, and then sends under the skin along the basilic vein a small branch, called the *long palmar* nerve (*N. ulnaris longus palmaris*), which anastomoses in the carpus with an analogous branch coming from the median nerve; about the middle of the fore-arm, it divides into two branches, a dorsal and a palmar.

The dorsal branch (*N. ulnaris dorsalis*) passes between the ulna and the tendon of the flexor carpi ulnaris muscle, comes on the back of the fore-arm, where it subdivides into two twigs.

The posterior or ulnar supplies the skin of the ulnar side of the hand, and becomes the *cubito-dorsal nerve of the fifth finger.*

The anterior or the radial also soon divides into two principal filaments, one of which is the *radio-dorsal nerve of the fifth finger* and the *cubito-dorsal nerve of the fourth,* the other is the *radio-dorsal nerve of the fourth finger.*

This dorsal branch is distributed like the dorsal branch of the radial nerve.

The palmar branch (*N. ulnaris palmaris*) which is larger, descends between the tendons of the ulnaris internus and the flexor digitorum communis muscles, and divides on the ulnar edge of the carpus into a superficial and a deep twig.

The deep or muscular twig goes downward and forward between the adductor and flexor minimi digiti muscles, passes across to the radial side of the hand, going between the tendons of the flexor communis and interossei muscles, and sends numerous twigs to the muscles of the little finger, to the interossei and lumbricales, and to the adductor pollicis muscles.

The superficial or cutaneous branch is smaller than the preceding, anastomoses by one or several filaments with the cubito-palmar branch of the median nerve (from this union we have a superficial palmar arch), and soon divides into two filaments, an anterior and a posterior.

The anterior soon divides into the *cubito-palmar nerve of the fifth finger,* and the common trunk of the *cubito-palmar nerve of the fourth,* and the *radio-palmar nerve of the fifth.*

Each finger receives two palmar and two dorsal branches, the first of which are the largest. They proceed along the radial and ulnar edges of the finger directly at the side of the digito-palmar artery, more inward and downward than it, that is, nearer the palmar face, as likewise the superficial palmar arch is nearer the surface than their trunk. They go to the extremity of the fingers. In this passage they give off several large branches, distribute some small twigs to the palmar face of the finger when they anastomose with each other.

VIII. INTERNAL CUTANEOUS NERVE.

§ 1842. The *internal cutaneous* nerve, *cubito-cutané*, Ch. (*N. cutaneus internus*), usually arises from the first dorsal by several roots; it sometimes though rarely comes from the ulnar, being the first branch. It descends directly below the skin at the side of the basilic vein in the arm. From its upper part arises the *superior cutaneous* nerve (*N. cutaneus internus superior*), which sometimes comes from the ulnar nerve, and is distributed to the triceps extensor muscle and the skin which covers it. A little lower it gives off the *inferior internal cutaneous* nerve (*N. cutaneus internus inferior*), which distributes its branches to the lower part of the triceps extensor muscle, to the skin of the elbow, to the integuments of the ulnar edge of the fore-arm, and to the carpus, and which terminates on the cubital edge of the hand and little finger, descending along the basilic vein, and anastomosing with the branches of the ulnar nerve, which it meets in its course.

In the whole course of this nerve its different branches anastomose frequently with each other, and with those of the external cutaneous nerve on the posterior side of the fore-arm.

B. SUPERIOR CERVICAL NERVES.

§ 1843. The four superior cervical nerves are smaller than the inferior. Like the latter their size increases progressively from above downward, so that the second and third are the largest. They form with the lower ones an uninterrupted series: and like them their anterior branches immediately after their trunks have come from the intervertebral foramina, give off twigs which anastomose with the adjacent branches and form the cervical *plexus*, *trachélo-sous-cutané*, Ch. (*plexus cervicalis*). This plexus descends along the corresponding vertebræ, below the sterno-cleido-mastoideus muscle, outside of the internal jugular vein, carotid artery, and pneumogastric nerve, on the scalenus posticus muscle. It anastomoses below with the brachial plexus, within with the superior and middle cervical ganglions of the great sympathetic nerve. We have as much reason to think the different branches of the cervical nerves are derived from them as that they arise from the cervical pairs themselves.

Some modern anatomists, among whom are Bichat * and Cloquet,† have adopted this method, and describe separately only the posterior branches and the commencement of the anterior, and consider the cervical plexus as the origin of all the nerves which arise after the union of the anterior branches. But we shall not follow

* *Anat. descript.*
† *Tr. d'anat.*, vol. ii. p. 633-641.

them, as the nerves of which they treat seem to arise from some particular pairs which are not seen in the other plexiform nerves of the spinal marrow.

The diaphragmatic nerve is the only one to be considered separately, because produced not only by several pairs of the cervical plexus but also of the brachial plexus, so that it seems to belong in common to the superior and inferior section of the cervical nerves.

I. DIAPHRAGMATIC NERVE.

§ 1844. The *diaphragmatic* or *phrenic* nerve (*N. diaphragmaticus*, s. *phrenicus*)* arises by several branches from the lower extremity of the brachial plexus. The largest branch is always furnished by the anterior branch of the fourth pair, but a smaller one always arises from the third and often from the second, and about three from the brachial plexus. This nerve sometimes joins the ascending branch of the hypoglossal nerve.

The diaphragmatic nerve descends on the side of the neck between the rectis capitis anticus and the scalenus muscle, gives branches to these muscles and to the thymous gland, anastomoses by a few filaments with the inferior and middle cervical ganglions of the great sympathetic nerve, enters the chest between the subclavian artery and vein, then goes forward, descends before the pulmonary vessels, and lastly passes between the internal wall of the external sac of the pleura and the pericardium, applied very exactly to the surface of this last membrane, and is finally distributed to the diaphragm. A little before arriving at this muscle, it divides into several branches which are united by intermediate filaments, some of which go to the convex face of the diaphragm and others pass through its costal portion and its central tendon, accompany the ascending vena-cava on the right, with which they emerge through the foramen quadratum, come into the abdomen, where they not only expand on the inferior face of the muscle, but also anastomose by several filaments with the solar plexus of the great sympathetic and with the gastric branch of the pneumo-gastric nerve. These anastomotic filaments almost always project at intervals, and these projections often form real ganglions.

The left diaphragmatic nerve is situated farther back, and is longer than the right, as it turns round on the summit of the heart. Besides the filaments it gives to the diaphragm, it sends some also to the lower part of the esophagus.

* Kruger, *De nervo phrenico*, Leipsic, 1758.

II. FOURTH CERVICAL NERVE.

§ 1845. The *fourth cervical* nerve * is a little smaller than the two adjacent. It emerges through the third intervertebral foramen, between the anterior and posterior intertransversarii muscles, and immediately divides into an anterior and a posterior branch.

The *posterior* is the smaller and deeper: it anastomoses with a branch of the third cervical nerve, gives a twig to the complexus muscle, passes transversely between this muscle and the semispinalis colli, to which also it sends large filaments, also to the multifidus spinæ, then penetrates between the complexus and trapezius muscles, and expands in the corresponding skin of the neck.

The *anterior* branch, which is the larger, first gives off the filament to the rectus capitis major anticus muscle: then it sends one of anastomosis to the cervical portion of the great sympathetic nerve, or to its superior cervical ganglion. It usually gives off also a twig to the descending branch of the hypoglossal nerve, and constantly sends filaments to the levator anguli scapulæ muscle.

It then sends an ascending anastomotic twig to the anterior branch of the third cervical, and forms with it the *third cervical nervous plexus*, then divides into three or four twigs, which also proceed from above downward, and are called the *supraclavicular* nerves (*N. supra-claviculares*). The latter are distributed principally to the skin which covers the clavicle and the shoulder.

The *anterior* (*N. supra-claviculares anteriores*) are distributed to the skin, which covers the first piece of the sternum and the sternal extremity of the clavicle to the mamma, anastomose with the anterior thoracic nerves coming from the fifth cervical, and send filaments also to the subclavius muscle.

The *middle* (*N. supra-claviculares medii*) are distributed to the trapezius muscle and the posterior belly of the omo-hyoideus muscle, and also to the skin which covers the body of the clavicle, its scapular extremity, and the scapula.

The *posterior* (*N. supra-claviculares posteriores*) go to the skin of the neck and of the shoulder.

A small ascending branch generally arises from the anterior or the middle nerve; this forms a very broad plexus by anastomosing with the middle subcutaneous cervical nerve, which comes from the third pair.

The middle and the posterior anastomose with the accessory nerve partly in the skin, and partly in the trapezius muscle.

* G. F. Peipers, *Diss. sistens tertii et quarti nervorum cervicalium descriptionem, cui accedit succincta eorundem nervorum quinti, nervi phrenici, præsertim ratione originis nervi duri ejusque præsertim rami inferioris, nervi hypoglossi et occipitalis maximi a secundo cervicalium nervo adumbratio*, Halle, 1793.

III. THIRD CERVICAL NERVE.

§ 1846. The *third cervical nerve* * is larger than the preceding. It emerges from the spinal canal between the second and the third cervical vertebræ, and divides into two branches, a posterior and an anterior.

The *posterior* branch is much smaller than the anterior; it proceeds from before backward between the anterior and posterior intertransversarii muscles, gives filaments to these two muscles, and also to the transversalis colli and the complexus minor muscles, goes backward passing on this latter, sends anastomosing filaments to the posterior branch of the second and third cervical nerves, and also to the small occipital nerve which comes from the anterior branch of the third pair, glides below the biventer cervicis nuchæ and the complexus major muscles, which receive considerable filaments from it, and goes directly to the trapezius muscle in which it is distributed, and also in the middle region of the skin of the neck.

The *anterior* branch sends first small twigs to the rectus capitis major anticus and to the longus colli muscles, then proceeds from above downward and divides into two branches, a descending and an ascending.

The *descending* branch, the *superficial cervical* nerve, the *submental* nerve, Ch. (*N. superficialis colli*, s. *profundus*, *N. sub-cutaneus colli medius*) turns on the posterior edge of the sterno-cleido-mastoideus muscle, to go to the outer face of this muscle, to which it gives filaments, sends others which anastomose with the ascending branch, and terminates first, by descending ramifications called the *middle* and *inferior subcutaneous cervical* nerves (*N. subcutanei colli medii et inferiores*), in the middle and lower part of the skin of the neck; second, by ascending twigs which anastomose frequently, both with each other and with the final twigs of the facial nerve in the skin which covers the ascending and horizontal branches of the lower jaw from the lobe of the ear to the chin, and thus form the *superior subcutaneous cervical* nerves (*N. subcutanei colli superiores*).

The highest and most posterior portion of this descending branch, or the *great auricular* nerve, the *zygomato-auricular* nerve, Ch. (*N. auricularis magnus*, s. *cervicalis*), goes directly upward, and passing behind the ascending branch of the lower jaw arrives at the external ear. Its ramifications are distributed from behind forward and from below upward in the integuments and posterior muscles of the external ear, and also in the skin of the auditory foramen.

The *ascending* branch goes backward and upward, gives off first an ascending anastomosing filament which unites to a descending filament of the third pair to form the *second cervical nervous plexus*, and often sends off immediately the great auricular nerve. In this case

* Peipers, *loc. cit.*—Vic-d'Azyr, *Mémoire sur les nerfs de la seconde et de la troisème paire cervicale*; in the *Mem. de Paris*, 1777, p. 21—40.

its posterior part, and when the great auricular nerve comes from the descending branch, its entire trunk becomes the *small* or the *anterior occipital* nerve (*N. occipitalis minor*, s. *anterior*), which most generally soon divides into several filaments, ascends on the complexus minor and splenius capitis muscles and expands in the skin of the occiput, in that of the mastoid process, in that of the posterior and superior part of the external ear between the superior and posterior auricular muscles, farther forward than the large occipital nerve given off by the second cervical pair, although anastomosing frequently with this latter, as with the filaments of the facial nerve.

IV. SECOND CERVICAL NERVE.

§ 1847. The *second cervical* nerve* emerges from the spinal canal between the first and second cervical vertebræ. It is larger than the third, and divides into an anterior and a posterior branch, directly below the ganglion.

The *posterior* branch, the *great occipital* nerve (*N. occipitalis maximus*), is much larger than the anterior, which is contrary to the arrangement of the inferior cervical nerves except the first, and to that of all the other spinal nerves. It goes directly backward below the complexus minor muscle, first sends filaments to the obliquus capitis inferior muscle, gives off others which pass on this muscle to anastomose with the first and third cervical nerves, also gives them to the upper part of the two splenii muscles, to the biventer cervicis, the complexus and trapezius muscles under which it proceeds, to the multifidus spinæ and to the skin of the neck, approaches the median line, and arrives at the occipital bone; it there forms most of the nerves in this region, ramifies to the lamboidal suture, where its filaments expand in the skin and occipitalis muscle, and anastomose with those of the facial and small occipital nerve.

The *anterior* branch is smaller than the preceding; it goes forward and outward under the obliquus capitis superior muscle, and soon divides into two anastomotic branches, a superior *ascending* (*N. anastomoticus adscendens*), and an inferior *descending* (*N. anostomoticus descendens*), which unite, the first with the anterior branch of the first cervical nerve, to form the *first cervical nervous plexus;* the other with the anterior branch of the third, to form the *second cervical nervous plexus.*

From the upper branch arise filaments which enter the superior cervical ganglion of the great sympathetic, the sublingual, and the pneumo-gastric nerve: one arises even from the bifurcation and goes into the superior cervical ganglion; finally, the inferior branch produces one which is larger, which descends from behind forward and anastomoses with a similar twig from the anterior branch of the third cervical nerve, and with the descending branch of the sublingual nerve.

* Vicq.-d'Azyr, *loc. cit.*

V. FIRST CERVICAL NERVE.

§ 1848. The *first cervical* nerve, called also the *sub-occipital* or the *tenth encephalic* nerve (*N. cervicalis primus*, s. *supremus*, s. *occipitalis*, s. *infra-occipitalis*, s. *decimus cerebri*),* is frequently the smallest of all the spinal nerves, since it is not unfrequently smaller than the last sacral nerve; at least it is always smaller than the other nerves of the spinal marrow except the last. By its situation, origin, and direction, it makes the transition from the spinal to the encephalic nerves, for it frequently in the same, and still more so in different subjects, resembles the former in some characters, the latter in others.

Hence for a long time, that is, since Willis lived, it has been considered as an encephalic nerve, the tenth cerebral nerve. It is not till lately that it has been generally admitted among the spinal nerves, to which it is more similar than to the cerebral nerves.

It arises out of the skull from the upper extremity of the spinal marrow between the occipital portion of the basilar bone and the first cervical vertebra.

Very often, perhaps even most generally, although Huber considers the existence of two roots as a constant fact,† it arises by one anterior root which, like that of the sublingual nerve, comes from the anterior cord of the spinal marrow.‡

Even when a posterior root exists, the anterior is much larger than it, and is composed of from two or three to seven fasciculi, rarely of eight, more commonly of two or three. These fasciculi, situated one above another, are also formed of smaller filaments The posterior root presents only from one to three, and rarely four filaments which are much smaller, the inferior of which, a remarkable fact, is generally much larger than the others: these filaments commonly unite in two fasciculi which proceed the superior outward, the inferior upward.

Even when the posterior root exists, the nerve however is most generally formed anteriorly by but one root, the anterior, for the latter ascends more than the posterior.

The posterior root is generally situated behind the accessory nerve; sometimes, however, but very rarely (we have never observed it), it passes before. It is then in this latter case unusually near the anterior, although the ligamentum denticulatum even then always separates it from them. Farther it is constantly nearer the anterior face than are the posterior roots of the other spinal nerves.

* G. T. Asch, *De primo pare nervorum medullæ spinalis*, Gottingen, 1750.—Sabatier, *Sur les nerfs de la dixième paire*; in the *Mém. présentés* vol. vii., p. 553.

† *De medullà spinali*, Gottingen, 1741, § 12.

‡ Morgagni (*Ep. anat.*, vol. xvi. 8vo.) also says: *Septies ab eo tempore ex quo semel anteriores tantam reperi, posteriores illas fibras quæsivi. Bis dubius hæsi. Quater procul omni dubio nullas omnino fuisse deprehendi. Semel a dextris—sed ne in eo quidem ipso—ullam prorsus fibram e sinistris.* - See also Vicq-d'Azyr, *Mém. de Paris*, 1781, p. 596.—Gordon, p. 214.—Cloquet, p. 631.

The posterior root most generally anastomoses with the accessory nerve. This is sometimes, although more rarely, the case with the anterior. Sometimes the posterior does not unite with the anterior; it goes only to the accessory nerve, in which case the latter after forming a small ganglion, which however does not constantly exist, sends one or two filaments to the anterior root of the second cervical nerve.

Sometimes instead of the posterior root we find only a plexus which anastomoses with the accessory nerve, the filaments of which go owards the opening destined for the passage of the first cervical ierve.*

When the posterior root and the accessory nerve do not anastomose, re generally find a filament which extends from this root to the posterior root of the second cervical nerve; but this filament is not constant.

The direction of the first cervical nerve is most generally transverse rom its origin to its emerging from the spinal canal. It not unfreuently proceeds in a direction opposite to that of the other cervical erves, that is, it proceeds a little more from below upward and from within outward like the cerebral nerves.

The superior filaments of the posterior root rarely go upward, and ie inferior downward. Still more rarely the inferior filaments of the wo roots have a direction from above downward, while on the ontrary the superior commonly follow this direction.

It is easy to observe that the smallness, the frequent absence, and e anterior situation of the posterior root, its separation from the anrior, the anastomosis of the latter with the accessory or the second ervical nerve, and the direction of the whole nerve, establish a great ialogy between the latter and the cerebral nerves, while the frequent istence also of the roots and their place of origin, establish a semblance with the spinal nerves.

§ 1819. The trunk of the first cervical nerve passes between the cipital portion of the basilar bone and the transverse process of the las, in the lateral groove of the vertebra below the vertebral artery, ter forming a very elongated, more or less apparent, and often almost iperceptible ganglion. It divides, as usual, opposite the posterior ge of the atlas into an anterior and a posterior branch.

The *posterior* is larger, and proceeds obliquely backward and iward, and divides into seven or eight radiating filaments which go the obliquus capitis minor, the obliquus capitis major, the rectus pitis major and minor, and the complexus muscles. Some penete within the mastoid process.

The *anterior* is smaller, goes first from behind forward along the rtebral artery to the place where this vessel leaves the vertebral nal, it then immediately ascends between the transverse process of

* Vicq-d'Azyr, *loc. cit.*, p. 296.

the atlas and the mastoid process. It then divides into four or five branches.

The first turns around on the transverse process of the atlas, proceeding from above downward, and anastomoses with one or two ascending filaments of the anterior branch of the second pair. It gives off some filaments which unite with the pneumo-gastric, the hypoglossal, and the great sympathetic nerve.

The second goes to the temporalis muscle.

The third enters the vertebral canal, is distributed to the vertebral artery, and sends filaments to the second cervical nerve.

The fourth and fifth arise before the transverse process of the first cervical vertebra, and are distributed in the rectus capitis major and minor muscles.

The peculiarity in the distribution of this nerve, is, that being situated very deeply, it sends off filaments only to these muscles and these vessels, and does not extend to the skin.

CHAPTER II.

ENCEPHALIC NERVES.

§ 1850. The following are usually mentioned as general characters of the *encephalic* nerves * to distinguish them from the spinal nerves.

1st. They arise by a single root.

2d. On leaving the dura-mater they do not produce any special ganglion without the concurrence of another nerve.

3d. They pass through foramina in the bones of the skull, or through very irregular fissures formed in them.

4th. They expand in parts other than the muscles of the skin, particularly in the organs of sense and the viscera.†

But of all these characters only the first is with difficulty of general application. The fifth pair is an exception to the second, as its semilunar ganglion is formed without the concurrence of any other nerve: we can even to a certain extent mention the olfactory nerve in this respect. The glosso-pharyngeal and the pneumo-gastric with the accessory nerve, also produce a considerable ganglion shortly after leaving the cranium. In fact, these latter unite to give rise to the ganglion: but first, the anomaly resulting from it disappears, when it is considered that these three nerves should be regarded as forming but one: second, almost all the cervical nerves anastomose with each

* J. D. Santorini, *Obs. anat.*, cap. iii.—A. Bergen, *De nervis quibusdam cranii ad novem paria hactenus non rêlatis*, Erfort, 1738.—Morgagni, *Ep. anat.*, xvi.—Sœmmerring, *De basi encephali et originibus nervorum e cranio egredientium*, Gottingen, 1778.—Id., *Tabula baseos encephali*, Francfort, 1799.—Stieck, *De quinque prioribus encephali nervis*, Gottingen, 1791.

† Huber, *De medulla spinali*, Gottingen, 1741, pp. 8, 9.—Asch, *De primo pare medullæ spinalis*, Gottingen, 1750, § xxvii.

other within the dura-mater by intermediate filaments, before that each produces its ganglion. As to the third character, it does not depend on the nerves, but only on the difference in the size and connections of the bones of the skull and the vertebræ. Besides, it is not so exclusive as has been asserted, since we not only sometimes find an opening in the first cervical vertebra for the first cervical nerve, but also the sacral nerves constantly pass through the foramina of a bone originally composed of several pieces immoveably articulated together. In animals we find foramina for the passage of the corresponding cervical nerves, not only in the first cervical vertebra, in all the mammalia except some apes, but also in the second, but even in several of the following in some of these animals, particularly the hog.

The insufficiency of the latter character seems no less evident when we consider, first, that the spinal nerves necessarily cannot go to parts which are not yet formed: second, that the lumbar and sacral nerves are distributed to the genital and urinary organs, and also to the latter portion of the intestinal canal.

It follows then that the distinction between the spinal and the encephalic nerves is not so well marked as we should be tempted to think at first view, and from the assertions of anatomists. Far from it: we shall demonstrate that it is very easy to refer the second to the first, and to show that they are both constructed after the same type.

§ 1851. We have already mentioned the principal differences in authors in respect to the number of the encephalic pairs they establish, and demonstrated that they depend on the different manner of bounding the different portions of the centre of the nervous system. But there are others depending on the fact, that some cerebral nerves have been regarded sometimes as distinct pairs, sometimes only as portions of pairs.

The old anatomists followed the first course, while the moderns, adopting the second, have increased the number of cerebral pairs, which has gradually risen from seven to twelve, and even according to Malacarne,* to fifteen.†

The twelve cerebral nerves most generally admitted now, are, proceeding from behind forward, 1st, the *sublingual*; 2d, the *accessory*; 3d, the *pneumo-gastric*; 4th, the *glosso-pharyngeal*; 5th, the *facial*; 6th, the *auditory*; 7th, the *external* or *posterior motor*; 8th, the *trifacial*; 9th, the *internal* or *superior motor*; 10th, the *common motor*; 11th, the *optic*; 12th, the *olfactory* nerve.

The reasons for admitting a smaller number of nerves are, first, the olfactory nerve was long considered, till the time of Massa, not as a nerve, but as a portion of the cerebrum: second, till the time of Achillini, the common external motor nerve of the eye was considered as part of the fifth: third, the auditory and the facial nerves have been

* *Neuro-encephalotamia*, Pavia, 1791.

† Malacarne numbers, properly speaking, seventeen; but the seventeenth is the posterior root of the suboccipital nerve, and the eleventh the sympathetic nerve.

considered as one till the time of Sœmmerring; fourth and fifth, till the time of Andersch, the glosso-pharyngœal and the accessory nerves have been considered only as portions of the pneumo-gastric nerve. Certain anatomists, however, and even before the preceding division was established by Sœmmerring's publication, had considered a greater or less number of the nerves mentioned, as distinct pairs.

Malacarne states the number of the encephalic nerves to be fifteen: first and second, by admitting an accessory nerve to the common motor and to the superior motor nerve; third and fourth, by considering the three branches of the trifacial as so many distinct nerves, which would make sixteen pairs, if instead of distinguishing the glosso-pharyngœal, it had not been united to the pneumo-gastric nerve. But this method is very objectionable, for even when Malacarne had cause to admit his accessory nerves to the motors, he could regard them only as the roots of these latter, to the trunks of which they unite: second, the three branches of the trifacial nerve arise by a common nervous trunk: third, the glosso-pharyngœal nerve deserves to be separated from the adjacent nerves, and considered as a distinct pair more than any which Malacarne insulates.

Farther, we shall have occasion hereafter to show that it would be more convenient to diminish than to increase the number of cerebral nerves, but at present we shall follow the common division.

The principle of the nomenclature of the nerves is not the same in all. Formerly the respective situation of their origin was taken for them, and they were numbered from before backward. Still later this method was preserved, but names drawn from their distribution and their uses were applied. This latter mode is undoubtedly the best, and we follow it much more willingly, because the first does not entirely agree with our mode of considering the nerves, commencing at the spinal marrow.

§ 1852. The cerebral nerves of man differ considerably in respect to volume, form, and origin.

1st. *Volume.* The cerebral nerves generally diminish in size in the following order: the trifacial, the optic, the olfactory, the auditory, the common motor, the pneumo-gastric, the glosso-pharyngœal, the facial, the external motor, the accessory, the hypoglossal, and the superior motor.

Form. Here we may consider—

1st. The *shape.* Most of these nerves are round; the external motor however is slightly flattened, and the olfactory is triangular.

2d. *Texture.* Almost all are fibrous from their origin; in the olfactory nerve alone there are no distinct fibres. In some, the fibres continue separate longer than in others, and they are the more so, the more posterior the origin of the nerves. They generally unite in fasciculi of various sizes before they blend in one trunk. These fasciculi are more numerous, and are more similar in size the more posteriorly the nerves are situated. The two anterior nerves form only one trunk on leaving the cerebrum.

We must mention here the differences in their substance and solidity. The eleven posterior cerebral nerves are composed, like the spinal nerves, of white substance; the olfactory, on the contrary, contains some which is grey. This nerve and the auditory are much softer than the others.

3d. *Origin.* In this respect,

a. The cerebral nerves succeed each other from behind forward.

b. All arise from the inferior part of the cerebrum. Some, particularly the hypoglossal, the accessory, the pneumo-gastric, the glosso-pharyngœal, the posterior motor, the trifacial, the common motor, and the olfactory, come from its lower face. The others arise more or less from its upper face.

c. The origins of some, as the trifasial and the common motor, are deeply concealed in the substance of the parts of the cerebrum from the surface of which they emerge. On the contrary, most of the others cannot be traced beyond the surface.

4th. *Direction* and *progress.* All go forward; but they differ from each other in this respect, that the direction of the posterior ten is forward and outward, while the optic nerve proceeds forward and inward at its posterior part, unites with that of the opposite side, and does not go outward till after this union. The course of the olfactory nerve is obliquely inward and forward.

I. HYPOGLOSSAL NERVE.

§ 1853. The *hypoglossal* nerve, *hypoglossien*, Ch. the *ninth cerebral pair*, the *twelfth* of the usual method (*N. lingualis medius*, Haller, *gustatorius*, Winslow; *lingualis*, Vicq-d'Azyr; *hypoglossus*, Winslow),* arises from the anterior face of the medulla oblongata, passes through the anterior condyloid foramen, and is distributed principally to the muscles of the tongue.

It commences by several fasciculi placed after each other from above downward. These fasciculi, arranged in a single series about half an inch long, describe a curved line, which is convex outward, as the superior and inferior are placed a little further outward than the central. They come from the groove between the pyramid and the olivary body. The inferior arise below this latter eminence; the superior begin a little above the centre of the groove. All are situated a little farther outward than the anterior roots of the first cervical nerve, the lowest of which are about two lines distant from above downward.

The whole series of these fasciculi corresponds with much exactness to the origin of the glosso-pharyngeal, and the pneumogastric nerves, and to that portion of the accessory nerve which arises from the medulla oblongata.

* J. F. G. Bœhmer, *De nono pare nervorum cerebri*, Gottingen, 1777.—H. F. Kilian, *Untersuchung uber das neute Hirnnervenpaar*, Perth, 1822.

They are always very distinctly separated from each other at their origin, and commence by several radicles, which are themselves generally composed of other small radicles.

They vary in their number and situation. We admit from four to eight of them. They usually succeed each other uninterruptedly, so that the smallest radicles of the different fasciculi touch each other. Sometimes, however, we observe some which are more remote from the others, and even about a line distant from them, so that this arrangement divides them into two or three bundles of different sizes.

These fasciculi reunite in cords which are generally two and sometimes three in number, each of which passing through a special opening in the dura-mater, proceeds from behind forward, from below upward, and from within outward, towards the posterior orifice of the anterior condyloid foramen. They rarely unite in a single trunk before they enter the dura-mater. Sometimes even an osseous septum divides them for the whole extent of the condyloid canal, into at least two halves, which unite only at the external orifice of this canal.

On leaving the cranium the trunk goes downward, proceeding on the upper part of the condyle, and covered outward in the extent of about an inch, by that of the pneumo-gastric nerve, with which it is generally united by filaments, it passes on the internal carotid artery, and descends from behind forward between the laryngœal branch of the pneumo-gastric and the accessory nerve.

In this place it unites at first near the summit of the transverse process of the first cervicle vertebra forward and upward by a considerable filament, with the pneumo-gastric nerve downward and backward, with the first cervicle nerve and the great sympathetic nerve by another filament which ascends from the anterior branch of the first, and from the superior cervicle ganglion, before which it is situated. It then descends, covered outward by the pneumo-gastric nerve, the posterior belly of the digastricus muscle, the stylo-glossus muscle, and the internal jugular vein, inward by the internal carotid artery, and gives ramifications to the submaxillary gland. When as high as the third cervicle vertebra, it passes before the external carotid artery, and forming a large arch, which is convex downward, it goes from behind forward and from below upward, towards the genio-glossus muscle, along the inside of the posterior and inferior hyoid bone.

At the origin of its arch it gives off a considerable and very constant branch, the *descending cervicle* nerve (*R. descendens noni*), which goes downward and forward, first along the anterior face of the external carotid artery, where it is intimately united to the trunk of the pneumo-gastric nerve by cellular tissue, then to the inner side of the internal jugular vein, passes above the superior thyroid artery, goes still farther forward on leaving this point, gives off forward and inward a branch which terminates in the anterior belly of the omo-hyoideus muscle, sends others to the muscles of the larynx, and again uniting in the middle of the neck with the descending nerve which comes from the anterior branches of the second and third cervicle

nerves, thus forms an arch, the convexity of which is well marked and turned forward.

The convexity of this arch usually gives rise to two branches, which descend along the anterior side of the internal jugular vein. The superior is smaller, and retrogrades to go to the anterior belly of the omo-hyoideus muscle. The inferior is larger, passes under the anterior belly of this muscle, goes downward and forward to the external face of the sterno-thyroideus muscle, distributes several filaments in this muscle and the sterno-hyoideus muscle, and anastomoses in this place by a small but constant filament, with the diaphragmatic nerve. Some ramifications of this branch enter the chest, particularly on the left side, and extend to the upper part of the pericardium.

The trunk of the hypoglossal nerve immediately gives off some branches which go downward into the thyro-hyoideus muscle. Thence it rises again, first below the tendon of the digastricus muscle, then on the external face of the hyoglossus muscle, gives filaments, of which the upper anastomose frequently from its upper and lower parts, but principally from this latter to the muscles of the larynx, then to the hyoglossus, to the genio-hyoideus, and to the genio-glossus muscle, unites with the lingual nerve of the third branch of the trifacial in the upper and anterior part of the hyoglossus muscle, by two or three considerable filaments, and afterwards extends almost to the point of the tongue by ramifications which proceed between the fibres of the hyoglossus muscle.

At the body of the hyoid bone the trunk of the nerve turns on the lingual artery, and enters the genio-glossus muscle, in which it terminates by branches, some of which go to the lower face of the point of the tongue.

We cannot follow the filaments of the hypoglossal nerve into the integuments of the tongue; they stop in the muscles of this organ. From this circumstance we might deduce the very probable conclusion that it serves only to excite the motions of the muscles, and that it is not the proper gustatory nerve, although it communicates by very large anastomoses with the lingual branch of the trifacial nerve, the ramifications of which penetrate distinctly into the integuments of the tongue. Another circumstance gives more weight to this conjecture, viz. the analogy between it and the motory nerves of the other organs of the senses which receive both nerves of sensation and of motion. That these two orders of nerves fulfil different functions, is demonstrated by the observation, that alterations, the primitive or accidental destruction of one of them, is attended only with the loss of one of the two faculties of the tongue, that of the taste when the affection is situated in the lingual branch of the trifacial nerve, and that of motility when the hypoglossal nerve is affected.* The loss of

* The sense of taste is lost in trismus, but the levator muscles of the lower jaw receive their nerves from the fifth pair and not from the hypoglossal nerve (Haller, *Elem. phys.*, vol. v. p. 112). The congenital absence of taste has been observed in a patient where the lingual branch went to the occiput and not to the tongue (Colombo, *De re anat.*, Paris, 1762, p. 486.)

taste in one case where the hypoglossal nerve was injured,* even when this lesion would not have been admitted as probable, would not prove that the two nerves concurred in the function of taste, for on one side the lesion might produce this effect only from the connections between the two nerves; and, secondly, a case cited by Heuermann would farther prove that it cannot be admitted, since on account of the distribution of the hypoglossal nerve and to the lingual branch of the trifacial nerve, the hypoglossal nerve could not alone be the nerve of taste, as should be concluded from this fact, considered as a peremptory argument in favour of the power attributed by the author to the nervous trunk supposed to be injured.

But the difference of function between the two nerves is not proved by the cases where the loss of the motion of the tongue without that of taste, or the loss of taste without that of the motion of the tongue† in general, have been observed, since the same phenomenon is seen in other parts which receive only one nerve, and which cannot consequently be explained in the same manner.

II. ACCESSORY NERVE.

§ 1854. The *accessory* nerve,‡ *trachelo dorsal*, Ch. (*N. spinalis ad par vagum accessorius, accessorius Willisii*),§ arises by numerous filaments from the posterior part of the lateral face of the posterior cord of the spinal marrow ascends between the posterior roots of the upper six cervical nerves and the ligamentum denticulatum, nearer the former than the latter, consequently also nearer the posterior than the anterior roots of the cervical nerves, penetrates into the skull through the occipital foramen behind the vertebral artery, receives some filaments from the latter parts of the medulla oblongata, is situated below near the pneumo-gastric nerve, with which it emerges from the skull through the posterior foramen lacerum, and is distributed partly in the upper region of the pharynx, partly also in some muscles of the back.

Its lowest and smallest root usually arises at the height of the superior filament of the posterior roots of the seventh cervical pair; the second at that of the upper part of the posterior root of the fifth; the third and fourth at that of the upper part of the fourth; the fifth opposite that of the third; the sixth between the second and third; and the seventh opposite the posterior root of the second. Many of these roots

* Heuermann, *Physiologie*, vol. ii. p. 295.

† Sœmmerring, *Nervenlehre*, p. 262.—Scarpa, *Tab. neurol.*, Pavia, 1791. p. 16-17. Two cases.

‡ Often termed the *accessory nerve of Willis*, but wrongly, as it had previously been figured by Eustachius and described by Coiter.

§ J. F. Lobstein, *De nervo spinali ad par vagum accessorio*, Strasburg, 1760.—A. Scarpa, *Uber den zum achten Paare der Gehirnnerven hinlaufenden Beinerven des Rückenmarnes*; in the *Abhandl. der Josephsakad*, vol. i. p. 385.—Its origin has been described perfectly by Huber, *De medullá spinali, speciatim de nervis ab câ provenientibus*, Gottingen, 1741, § vii-xi.

sometimes communicate in one or several points with the anastomotic filaments of the middle and superior cervical pairs.

Usually no root of the accessory nerve arises from a higher point of the spinal marrow.

Sometimes, however, the whole posterior root of the first cervical nerve joins it and forms with it a small ganglion. But this ganglion is not constant when the nerves unite, and we should even think it extremely rare, since it has never been observed by Haller, Ash, Lobstein, and Scarpa, who have remarked only a slight thickening of the nerve.* We have never seen it but a few times, notwithstanding our numerous researches.

Three or four roots generally arise within the skull from the lateral face of the posterior cord of the medulla oblongata; these are behind the roots of the hypoglossal nerve.

These ten or eleven roots gradually become longer and thicker from below upward, and go towards the trunk of the nerve at angles which are more acute the lower their origins. The lowest is in great part concealed in the pia-mater, through which it only penetrates. The spinal roots also are usually single, while those arising from the medulla oblongata are generally composed of two short radicles united at an acute angle, each of which is formed by three or four filaments. These radicles, one of which is superior, the other inferior, and the second of which ascends in a more perpendicular direction, soon reunite. In considering the whole series of roots, we recognize that they gradually become more anterior from below upward.

The nerve enlarges as it ascends, goes imperceptibly outward, and is attached above by short filaments to the trunk of the pneumo-gastric nerve.

The accessory nerve never arises lower than the point indicated. On the contrary it often commences higher, opposite the sixth cervical vertebra, sometimes even but more rarely opposite the fifth. In some subjects it receives from the spinal marrow only two or three roots, which are then proportionally thicker.

The number of the filaments from the medulla oblongata is sometimes less than we have mentioned: it is rarely and perhaps never greater. Sometimes they resemble, by being single, those which arise from the spinal marrow.

So likewise the accessory nerve does not always arise exactly in the same place.

It is very rarely united by a filament with the posterior root of the second cervical nerve.†

It does not anastomose with the hypoglossal nerve within the skull.‡

* Scarpa, *loc. cit.*, p. 396.

† Scarpa, *loc. cit.*, p. 395. This anatomist has observed this union only twice in his numerous dissections. We have found it only once.

‡ Scarpa, *loc. cit.*, p. 397, does not admit this assertion of Winslow. We have never seen the anastomosis mentioned by this latter.

It generally passes through the dura-mater in connection with the pneumo-gastric nerve: but sometimes also it emerges through a special opening behind the latter, with which however it reunites.

All these differences are observed not only in different persons, but frequently in the same person on different sides of the body.

In passing through the dura-mater the accessory nerve is inclosed in a sheath with the pneumo-gastric nerve; but before emerging through the posterior foramen lacerum it divides into an internal and an external branch.

The *internal* branch gives off first two branches which unite with each other, and with a third which descends from the pneumo-gastric nerve, and produces the *superior pharyngœal nerve*. It then receives some filaments from the pneumo-gastric nerve, sometimes communicates with the hypoglossal nerve, then reunites with the trunk of the pneumo-gastric nerve to form a ganglion.

The *external* branch proceeds for about two inches descending deeply behind the internal jugular vein, at first between this vessel and the occipital artery, then between it and the sterno-cleido-mastoideus muscle. It turns a little on this muscle and goes forward, somtimes passes through it, gives to it filaments which anastomose with those of the third cervical nerve, then continues to descend but from before backward, passing on the internal jugular vein, enlarges considerably by uniting with two anastomosing branches, the upper of which arises from the anterior branch of the second cervical nerve and the lower from that of the third, passes on the levator anguli scapulæ muscle, anastomoses with the ramifications of the fourth and fifth cervical nerves, and comes to the internal face of the trapezius, in which it is distributed. No other muscles receive filaments from it.

III. PNEUMO-GASTRIC NERVE.

§ 1855. The *pneumo-gastric*, the *par vagum*, the *middle sympathetic*, the *pulmonary*, the *vocal* nerve, the *eighth*, or according to the new calculation, the *tenth* pair (*N. pneumo-gastricus*, Chaussier; *N. vagus*, *N. sympathicus medius*, Winslow; *N. pulmonalis*, Bartels;* *par octavum*, Willis;† *decimum*, Andersch,)‡ arises from the side of the posterior prolongation of the cerebellum between the accessory and the glosso-pharyngœal nerves, emerges from the skull through the posterior foramen lacerum, and descending is distributed

* *Respiration*, p. 210.

† This term, however, includes the following or the glosso-pharyngeal nerve.

‡ Neubauer, *Descript. nerv. cardiac.*—Andersch, in the *Nov. comm. Gott.*, vol. ii. published in Haase *Cerebri nervorumque anat.*, Leipsic, 1781, and in Ludwig, *Script. neurol.* vol ii.—Walter, *De nerv. abdom.*, Berlin, 1800.—Wrisberg, *De ganglio plexuque semilunari*, *&c.* sect. ii. *De pari octavo*; in the same *Comment.* vol. i. 1800.—Scarpa, *Tab. neurolog.* Pavia, 1794.

in the upper part of the alimentary canal, the stomach; second in the organs of respiration; hence the term *pneumo-gastric*.

§ 1856. It arises by from ten to sixteen filaments from the lower part of the lateral face of the posterior prolongations of the cerebellum. The inferior are situated far behind the anterior, and form a series which is generally single and five or six lines long. Sometimes, however, several are more anterior than the others;* this is particularly the case with those at the top of the series, although there is no disposition indicating any tendency to produce distinct roots. On the contrary, in this formation the pneumo-gastric nerve is similar to the formation of the anterior cerebral nerves, as its origin is thus more rounded, which form is remarkable in several of the mammalia, particularly the ruminantia. These filaments arise principally towards the anterior and inferior edge of the posterior prolongation of the cerebellum, in the groove between this prolongation and the olivary body. They do not extend so high as this latter, and terminate below long before those of the hypoglossal nerve. Some of them frequently anastomose with the transverse medullary striæ on the floor of the *calamus scriptorius*, and hence these striæ seem to concur in their formation.† Others, particularly some of the inferior, come from the lower extremity of the olivary body.‡

These filaments are generally single, and not cleft at their internal part. They are sometimes separated and sometimes united from their origin in three or four fasciculi. The inferior are commonly very intimately connected with the accessory nerve. The superior most generally communicate by a transverse filament with the glosso-pharyngœal nerve even within the skull.

These filaments and fasciculi unite in a flattened trunk about one line and a half broad, one quarter or one fifth of a line thick, and always larger at its upper part where they are interlaced with each other. This trunk goes outward and backward. It is inclosed in a small canal of the dura-mater, through which it comes from the cranium, through the anterior part of the foramen lacerum, before the origin of the internal jugular vein. It is separated from this vein by a prominence of bone which comes from the petrous portion of the temporal bone or from the occipital bone, or from both, and from the accessory and the glosso-pharyngœal nerves by the dura-mater.

The fasciculi hitherto distinct do not entirely unite in a rounded cord except within this canal. The rounded cord on leaving the foramen lacerum is united very intimately by mucous tissue with the glosso-pharyngœal nerve, the hypoglossal and the ascending branch

* Coopmans, *Neurol.*, p. 118.—Sœmmerring, p. 102.

† Desmoulins, *Sur le rapport qui unit le developpement du nerf pneumo-gastrique à celui des parois du quatrième ventricule*; in the *Journ. de phys. experimentale*, vol. iii. p. 362.

‡ Vicq-d'Azyr, *loc. cit.*, p. 594.

of the superior cervical ganglion. It is situated at first behind the glosso-pharyngœal and before the hypoglossal nerve, but it soon passes behind this latter, is separated from the glosso-pharyngœal nerve by the internal jugular vein, leaves the hypoglossal nerve on the transverse process of the first cervical vertebra, and descends outward and a little backward before the primitive carotid artery, between it and the internal jugular vein, intimately united to these two vessels by a mucous tissue destitute of fat and more loosely connected to the intermediate filaments of the sympathetic nerve which are situated behind it, and placed in the rectus capitis major anticus and the longus colli muscles.*

In passing through the foramen lacerum the pneumo-gastric nerve anastomoses by some filaments with the accessory nerve, and shortly after leaving this opening it communicates also with the glosso-pharyngœal nerve and the superior cervical ganglion. It then gives off a branch, which unites with two filaments from the inner branch of the accessory nerve, and gives rise to the *pharyngœal* or *superior pharyngœal* nerve (*N. pharyngœus*, s. *pharyngœus superior*, s. *primus.*)

This nerve goes obliquely from above downward and from without inward on the inside of the internal carotid artery, sends an anastomosing filament to the glosso-pharyngœal nerve, bulges a little, and forms at the height of the middle constrictor of the pharynx a considerable plexus termed the *pharyngœal* (*plexus pharyngœus*). This plexus receives filaments from the laryngœal, the glosso-pharyngœal nerves, and from the superior cervical ganglion; its filaments are distributed principally in the middle constrictor, but some go to the upper constrictor of the pharynx: a few descend along the primitive carotid artery, where they anastomose with the ramifications of the glosso-pharyngœal and the superficial cardiac nerves.

The *inferior pharyngœal* nerve (*N. pharyngœus inferior*, s. *minor*), which also is not constant, arises directly below the superior pharyngœal nerve. This nerve soon anastomoses with the preceding, and also with one or several of the anterior filaments of the superior cervical ganglion, sends filaments to the pharyngœal plexus, and is distributed in the middle constrictor of the pharynx.

At the place where the pharyngœal nerves are given off, and sometimes also a little higher, the trunk of the pneumo-gastric nerve becomes much thicker and its texture is closer for about an inch: its fasciculi separate very much, and a reddish gelatinous substance is deposited between them. A real ganglionary plexus then forms. The remnant of the internal branch of the accessory nerve, after sending an anastomotic twig to the pharyngœal nerve, enters this plexus at about its centre, sometimes in one branch, sometimes also in several filaments which ramify and interlace differently, so that this branch forms the

* J. H. Haase, *De nervo phrenico dextri lateris duplici parisque vagi per collum decursu*, Leipsic, 1790.

ower part of the plexus, and seems also to belong to the pneumo-gastric nerve.

The trunk of the pneumo-gastric nerve is in fact directly attached to his ganglion from before backward; but it is sometimes, although rarely, connected with it only by some filaments of communication.

A more distinct development of this plexiform dilatation of the nerve occurs when it divides into two portions which unite only at the lower part of the neck; but such an arrangement is extremely rare: it has been observed only once in five hundred cases, and this was on the right side.*

The *superior laryngœal* nerve (*N. laryngœus superior*), which is commonly larger than the inferior, usually arises from the upper part of this ganglion.

This nerve descends between the internal carotid artery and the superior cervical ganglion, most generally anastomoses by one or several filaments with this latter, the pharyngœal plexus, and the hypoglossal nerve, and divides into an external and internal branch.

The *external* goes inward, and sends filaments to the inferior constrictor muscle of the pharynx, the crico-thyroideus, the sterno-thyroideus, and the hyo-thyroideus muscles, to the thyroid gland, and to the membrane of the pharynx; these filaments enter the cavity of the larynx between the cricoid and thyroid cartilages.

The *internal* branch passes through the hyo-thyroid membrane between the hyoid bone and the thyroid cartilage. It distributes soft and thick filaments in the membrane and glands of the epiglottis, the mucous membranes of the pharynx and larynx, several small muscles of the larynx, particularly the arytenoideus and the crico thyroideus, and anastomoses with the filaments of the inferior and recurrent laryngœal nerve.

After the superior laryngœal nerve, we see arise either from the ganglionnary plexus, or directly below it, some filaments which are not constant; these unite to the descending branch of the hypoglossal nerve, and also to the first cervical nerve, and to the soft nerves which go to the internal carotid artery.

After giving off these branches, the trunk of the pneumo-gastric nerve becomes more compact, and descends in the manner mentioned above, but gives off no ramifications. It then represents a cord composed of less distinct fasciculi, and which is generally uneven by a kind of indentation, but its surface is surrounded here and there by very minute filaments which interlace like a plexus.† It gives off about an inch or an inch and a half above the origin of the primitive carotid artery (but an inch higher on the right than on the left side), and at about the centre of the neck, on both sides, the *cardiac* nerves (*R. cardiaci*). These descend from within outward and from behind

* Wrisberg, *De nervis pharyngis*; in Ludwig, *loc. cit.* vol. iii. p. 57.

† Prochaska, *De struc. nerv.*, tab. ii., fig. 7, 7, ee.—Reil, *De struct. nerv.*, tab. i., f. 2, 3, 4.

forward in the carotid artery and the innominata trunk, anastomose with the superficial cardiac nerves, and are distributed to the arch of the aorta. We generally find three or four on the right side, the upper of which is the largest and most constant. There are one or two on the left side.

The trunk of the pneumo-gastric nerve goes forward, is situated behind the innominata vein, passing on the right before the subclavian artery, on the left before the arch of the aorta, thus comes into the chest, enlarges considerably, and divides into two halves, of which the lower and larger is the continuation of the trunk, and the upper is smaller, and is termed the *inferior laryngœal ascending* or *recurrent* nerve, *tracheal*, Ch. (*N. recurrens*, s. *adscendens*, s. *laryngeus inferior*).

The two recurrent nerves arise within the chest, the left much lower than that of the right side. They ascend first from before backward, then vertically, send some filaments to the cardiac nerves which come from the pneumo-gastric, the middle and inferior cardiac nerves which come from the ganglionnary nerves, form with them a plexus, then turn from before backward, the right on the right subclavian artery, the left on the extremity of the arch of the aorta, and are placed behind the primitive carotid and inferior thyroid artery, between the trachea and the esophagus, and rise to the larynx. In this course they give off first the branches called the *superior tracheal* nerves (*R. tracheales superiores*), which descend before the trachea and anastomose with the preceding, arrive at the bronchia and the pulmonary plexus of their side, are distributed in the membrane of the trachea, the pharynx, and the thyroid gland, and communicate with some filaments of the cervical portion of the sympathetic nerve.

Finally, when as high as the larynx the recurrent nerve is distributed in the inferior constrictor of the pharynx and the cricoarytenoid muscles, enters the cavity of the larynx between the cricoid and thyroid cartilages, and terminates in the thyroid cartilage, the arytenoid muscle, and the mucous membrane of the larynx, by anastomosing by several branches with the superior laryngœal nerve.

The recurrent nerve is sometimes double, but this is rare, and when it occurs it is always on the right side, if we judge from observations made hitherto. The unusual nerve is smaller than the other, and arises from the trunk some lines below it, turns like it on the subclavian artery, ascends between the esophagus and the trachea, anastomoses by a large twig with the normal recurrent nerve, and is distributed with the latter.*

This anomaly seems to indicate an effort to establish a perfect similarity between the right and left sides, since the recurrent nerve always arises lower than that of the right side.

It is very probable that the recurrent nerve results from the plexiform division of the trunk of the pneumo-gastric, and that its existence

* Wrisberg, *De nervis abdominis*, Gottingen, 1780.

is connected with the primitive shortness of the neck, since the larynx is much nearer its origin in the early periods of life than subsequently. This hypothesis would explain its arrangement in the same manner as the high origin and long course of the spermatic vessels. Farther, it is impossible to deny the analogy between the distribution of the nerves and vessels in this region of the body, since the superior and inferior laryngœal nerves and the superior and inferior thyroid arteries manifestly correspond.

§ 1857. The trunk of the pneumo-gastric nerve having given off the recurrent nerve, goes backward on the posterior face of the trachea. There it supplies first five or six *inferior tracheal* nerves (*V. tracheales inferiores*), some of which proceed before, others behind the trachea. The former anastomose with the filaments of the superior tracheal nerves and with others coming from the inferior cervical ganglion. Some descend before on the ramifications of the bronchiæ and of the pulmonary artery. Others enter the muscular and mucous tunics of the trachea, bronchia, and esophagus, and terminate in the *pulmonary plexus* (*plexus pulmonalis*).

This plexus commences directly above the bronchia of each side. It is formed principally by the fasciculi of the trunk of the pneumo-gastric nerve, between which there is a very vascular mucous tissue. It extends behind the bronchiæ into the substance of the lungs, surrounding the finest ramifications of the bronchial tree, to the muscular tunic, and even to the mucous membrane to which it sends filaments. Beside the trunk of the pneumo-gastric nerve which develops itself to give rise to it, it also receives some filaments which are less numerous, from the superior thoracic and from the inferior cervical ganglion of the great sympathetic nerve.

Five or six fasciculi on the right side, and only two or three on the left, arise from the lower part of each of these two pulmonary plexuses. These fasciculi are first situated very far from each other, but frequently anastomose by intermediate filaments. After passing some lines they unite on each side in a cord, which is the continuation of the trunk of the pneumo-gastric nerve, and the right of which is larger than the left. These cords descend, that of the left before, that of the right behind, and at the side of the esophagus.

In their course they frequently anastomose principally by anterior filaments which descend from the right cord, send filaments to the esophagus, and others which are smaller to the aorta, and enter the abdomen with the esophagus, passing through the esopahgœan fissure of the diaphragm.

The pneumo-gastric nerve terminates in the stomach. That of the right side, which is the largest, goes to the right portion and the posterior face of the viscus; that of the left side is distributed in its left part and on its anterior face.

The *right* forms around the cardiac orifice a large plexus, from which numerous filaments arise, some of which are distributed to the posterior face of the stomach; others situated behind the coronary

artery of the stomach, proceed along its small curve to the pylorus, and there anastomose with those of the left nerve, and with the superior gastric plexus of the great sympathetic nerve: finally, some which do not belong to the stomach pass behind it, arrive at the right portion of the solar plexus and also the plexuses which come from this latter on the right side, and are distributed to the hepatic artery and its branches, to the vena-portæ, the duodenum, and the pancreas.

The *left* divides at the cardiac orifice into several branches which separate in rays, communicate less frequently, follow the small curve of the stomach from left to right, send ramifications to the anterior face of this viscus, anastomose near the pylorus with the filaments of the right pneumo-gastric nerve, and leaving the stomach terminate anteriorly before the pylorus, in the hepatic plexus formed by the ganglionnary nerve.

IV. GLOSSO-PHARYNGŒAL NERVE.

§ 1858. The *glosso-pharyngœal* nerve (*N. glosso-pharyngœus*, Haller; s. *lingualis pneumogastrici*, Vicq-d'Azyr; s. *octavus*, Andersch), has been considered until lately as the anterior part of the pneumogastric nerve. In fact, if we regard its origin, the communications between it and this nerve, both within the skull and at its passage through the posterior foramen lacerum, finally the manner in which it is distributed, we discover that it really forms a part of the pneumogastric nerve, but it is so largely developed that it may be considered a proper and distinct nerve. It arises by five or six filaments, which may be easily separated from each other, and the anterior of which are generally smaller than the posterior. It arises between the pneumogastric and facial nerves, some distance behind the latter, but directly before the upper filaments of the first, from which its own cannot be separated. It comes from the upper part of the lower face of the inferior prolongation of the cerebellum, from the depression between this cord, the olivary bodies, and the posterior edge of the annular protuberance, directly behind the latter, from which several of its filaments sometimes emanate. It goes outward and at first a little forward, covered by the fourth lobe of the cerebellum, usually anastomoses within the skull by a large branch with the pneumo-gastric nerve,* and after proceeding five or six lines, passes through the arachnoid membrane. It is round and about a half or three quarters of a line thick, and emerges from the skull through the anterior part of the posterior foramen lacerum, directly before the pneumo-gastric nerve, but inclosed in a special canal of the dura-mater. About four or six lines from its entrance into this canal, it becomes a small, oblong, rounded, and generally very distinct ganglion about five lines long, which extends into the canal of the dura-mater and the anterior part of the foramen lacerum.

* Andersch, *Fragm. descript. nerv. cardiac.*, in Ludwig, *loc. cit.*, vol. ii. p. 115

This ganglion gives off, above, a filament, which enters into the cavity of the tympanum, and then divides into two branches; one ascends along the promontory, gives off a small filament to the membrane of the foramen rotundum, and passes through the petrous portion of the temporal bone to the superficial temporal nerve, and the other passes below the osseous portion of the Eustachian tube, and goes to the carotid canal, where it anastomoses with the great sympathetic nerve.*

The ganglion also gives off other filaments, which pass through the canal of the dura-mater to go to the trunk of the pneumo-gastric, to the accessory, and the great sympathetic nerves.

After emerging from the posterior foramen lacerum, the glosso-pharyngœal nerve is separated from the pneumo-gastric trunk by the internal jugular vein, before which it is situated. Thence it goes downward and forward, passing on the internal carotid artery, descends situated at first closely on the outside, then on the anterior part of this artery, between it, the external carotid artery, and the stylo-pharyngœus muscle, passes between this muscle and the glosso-pharyngœus muscle, then between this latter and the hyoglossus, and thus comes to the lower and posterior part of the tongue.

On leaving the skull it sends a filament of anastomosis to the stylo-hyoid branch, or to the digastric branch of the facial nerve, and another to the trunk of the pneumo-gastric nerve. It then gives off one or two which descend along the internal and the primitive carotid arteries, anastomose first with the pharyngœal branch of the pneumo-gastric nerve, and then going to the lower part of the neck communicate with some filaments of the sympathetic nerve, particularly with the superficial or even the middle cardiac nerves. Still farther on, it sends off three or four filaments to the stylo-pharyngeus muscle, and also to the middle and superior constrictors of the pharynx and to the amygdalæ, and some of which enter the pharyngeal plexus of the pneumo-gastric and the ganglionnary nerve.

The glosso-pharyngœal nerve then passes between the stylo-glossus and hyoglossus muscles; then situated in the tongue below the lingual nerve of the fifth pair and above the hypoglossal nerve, both larger than it, and with which it does not communicate at least by very evident filaments, it is distributed partly in the muscles of the tongue, the membrane of the soft palate and the amygdalæ by several ramifications which interlace like a plexus; partly in the teguments of the base of the tongue, its large papillæ, and the mucous membrane of the epiglottis by other filaments, which are situated lower and nearer the median line than the preceding, and pass from below upward through the substance of the tongue.

* Rosenmuller, *Handbuch der Anatomie*, 1816. p. 407.—Jacobson, in the *Acta . societ. Hafniensis medicæ*, vol. v. Copenhagen, 1818. p. 292.—This anastomosis has been doubted by Kilian, but is admitted by Lobstein.

V. AUDITORY NERVE.

§ 1859. The *auditory* or *acoustic* nerve, *labyrinthique*, Ch., the *soft portion of the seventh pair* (*N. auditorius*, s. *acusticus*, s. *portio mollis nervi acustici*),* is very soft, but harder than the olfactory and the portion of the optic nerve behind the decussation; it generally communicates so evidently with all the white striæ of the floor of the *calamus scriptorius*, or at least with several of them, that it may be said to arise partially from it.

Its upper and external part is formed by these striæ. The fibres connected with it follow one another from before backward and are separated by unequal and inconstant spaces; they turn on the inferior prolongations of the cerebellum, on the surface of which they are intimately connected. Their direction is forward and downward, the anterior proceeding transversely, the posterior obliquely from below upward.

The inner part of the nerve is larger than the external portion, but they are not separated; it arises below and farther forward than it from the lateral face of the spinal prolongation of the cerebellum, directly before and above the glosso-pharyngœal nerve and the upper part of the pneumo-gastric nerve.

The trunk of the nerve then goes forward, outward, and downward on the posterior edge of the transverse prolongation of the cerebellum, and is united to its upper face so intimately for about three lines, that it may properly be considered as arising from this part of the encephalon. It is slightly covered outward by the fourth lobe of the cerebellum, being often attached in this place to its medullary substance, so that we may admit also that it partially arises there, which is worthy of note but not astonishing, on account of the analogy resulting from it with what is seen in the other two nerves, the optic and olfactory, which are only nerves of sense.

Its internal face is grooved lengthwise, and receives the facial nerve. It is soft at its origin, and we do not perceive there distinct fibres, but on leaving the encephalon it evidently becomes fibrous and still more solid.

On leaving its origin the auditory nerve goes obliquely forward, outward, and upward, and soon penetrates the internal auditory foramen, which is much larger than it. It then divides into two branches, which continue united externally to its base; the *anterior* enters the cochlea, and the *posterior* the vestibule and the semicircular canals. We shall describe these branches when speaking of the ear.

* J. F. Meckel, *Obs. anat. sur la glande pineale, sur la cloison transparente et sur l'origine de la septième paire*, in the *Mém. de Berlin*, 1765. p. 91-100.—A. Scarpa, *De nervo auditorio*, in his *Anat. disquis. de auditu et olfactu*, Pavia, 1789, sect. ii. cap. iii.

IV. FACIAL NERVE.

§ 1860. The *facial* or small *sympathetic* nerve, the *hard portion of the seventh* nerve, the *seventh pair*, the *seventh cerebral* nerve, (*N. facialis*, s. *sympathicus minor*, s. *communis facili*, s. *portio dura septimi*, s. *nervus primus septimi paris*, s. *par septimum*)* is much smaller than the auditory nerve; it arises by two roots which are generally distinct, although placed one against the other. One is external and posterior, the other much larger is internal and anterior. It arises within, below, and before the auditory nerve, which receives it in a groove situated along its internal face, directly at the side of this nerve and before the glosso-pharyngœal nerve. It arises from the posterior edge of the annular protuberance, from the uppermost part of the lower face of the rachidian prolongation of the cerebellum; sometimes, also, according to Malacarne, by several filaments from the floor of the fourth ventricle, that is, from the most anterior transverse medullary striæ. The filaments from the annular protuberance, particularly the internal, seem to come only from this tubercle; but examining them attentively, we see that they are separated from the principal root only by the posterior fibres of the protuberance existing between this latter and them.† Very possibly, however, from this reason they are in fact separated from the principal root, and first arise from the pons Varolii. The external root of the nerve, which is much smaller than the internal, is always formed of three or four filaments which unite anteriorly in one or two fasciculi. It is situated between the internal root and the auditory nerve, and some of its filaments frequently seem, at least in situation, to belong to the auditory nerve rather than to it.

The nerve leaves the annular protuberance at about the centre of the space between the anterior and posterior edges of this latter, goes forward and outward to arrive at the internal auditory passage, through which it proceeds above and before the auditory nerve to the canal of Fallopius, which it exactly fills, and passes entirely through it. Its direction is consequently first outward and backward, then downward behind and above the cavity of the tympanum, and it emerges through the stylo-mastoid foramen, to be distributed in a considerable portion of the skin and of the muscles of the head.

In its course along the canal of Fallopius, it gives off first downward and forward, a filament which reunites with the superior branch of the recurrent nerve given off by the second branch of the fifth pair, to form the *superficial petrous* nerve (*N. petrosus superficialis*).

* J. H. Meckel, *De quinto pare nervorum cerebri*, Gottingen, 1748, for the portion of the facial nerve contained in the Fallopian canal.—J. F. Meckel, *Dissertation anatomique sur les nerfs de la face*, in the *Mém. de Berlin*, vol. vii. 1752.—See also Bock, *Beschreibung des funften Nervenpaares*, Leipsic, 1817. tab. i. ii.

† Gall, *loc. cit.*, p. 206.

It then gives off a little downward and outward, behind the cavity of the tympanum, one or several filaments for the muscles of the little bones of the ear.

A little lower, some distance above the stylo-mastoid foramen, it sends off a considerable branch, the *cord of the tympanum* (*chorda tympani*), which descends at first along the trunk, then goes outward and upward, passes through the posterior wall of the cavity of the tympanum, enters this cavity at the side of the pyramid, descends from behind forward between the malleus and incus situated on the former bone; it anastomoses by one or more filaments with the tympanitic nerves of the fifth pair, but gives no ramification to the membrane of the tympanum, leaves the tympanum through the fissure of Glaser, descends on the inside of the ascending branch of the jaw, and gradually becoming thicker, anastomoses at an acute angle with a twig of the lingual branch of the trifacial nerve which meets it.

It does not seem to us probable, from our dissections, that the superficial petrous nerve and the cord of the tympanum, are only a filament of the fifth pair, which is fitted to the facial nerve, and which does not really anastomose with it,* although we consider the lower and prominent portion of the cord of the tympanum as belonging to the branch of the trifacial nerve.

After leaving the stylo-mastoid foramen, the facial nerve gives off the following branches :—

1st. One single or double branch, termed the *posterior, inferior* or *deep auricular* nerve (*N. auricularis posterior, profundus inferior*), which sends one or more inconstant filaments into the mastoid process, then goes upward and backward, and divides into two branches, an anterior and a posterior, the former of which is the larger.

The posterior, which sometimes forms the first branch of the facial nerve, ascends on the mastoid process, is distributed in the skin which covers it, extends to the occipitalis muscle, to which it distributes filaments, and anastomoses with the ramifications of the small occipital nerve.

The anterior arrives at the lower and posterior part of the cartilaginous portion of the auditory foramen, and of the external ear, sends some filaments to the skin of this region, and also to the posterior auricular muscle, and passing through the cartilage, is distributed in the integuments of the auditory passage.

2d. The *stylo-hyoid* nerve (*N. stylo-hyoideus*) which is distributed partly in the upper portion of the muscles attached to the styloid process, and the posterior part of the digastricus muscle of the jaw, and partly sends several anastomosing filaments to the upper part of the ganglionnary nerve, and to the middle cutaneous nerve, given off by the third cervical nerve.

3d. A branch termed the *digastric* (*R. digastricus*), which passes through the posterior belly of the digastricus muscle, and anastomoses

* Cloquet, *Tr. d'anat.*, vol. ii. p. 610.

with the ramifications of the glosso-pharyngœal, the pueumo-gastric, and the accessory nerves.

4th. Sometimes a filament which anastomoses with the posterior twig of the inferior auricular nerve, and with the filaments of the anterior branch of the third and fourth cervical nerves. This filament exists particularly when the inferior auricular nerve is small.

After giving off these ramifications, the trunk of the facial nerve, passing under the ear, enters the parotid gland from above downward and from behind forward, assumes in this gland a direction which is oblique from below upward, still continuing to go forward, and forms within it a considerable plexus, the *parotid plexus* (*plexus parotideus*). This plexus is formed by the nerve dividing at the posterior edge of the ascending branch of the jaw, into from two to five branches, which may always be referred to two, which vary in direction and distribution. Of these branches, one is superior, the other inferior, and smaller than he former. They anastomose frequently together, and thus form a polygon convex forward, upward and downward, whence arise the other ramifications of the nerve, which are distributed in the skin of he upper, middle, and lower portions of the face, in that of the upper part of the neck and in most of the muscles of the face.

Several considerable branches constantly unite posteriorly with this lexus; they come from the superficial temporal nerves which arise rom the third branch of the trifacial nerve, and which turn from be-ind forward on the posterior edge of the ascending branch of the aw.

By examining this plexus from above downward and from behind rward, we observe that it gives off some ascending, some anterior, nd some descending branches, which frequently anastomose together r intermediate twigs, equally distant from the edge of the parotid and.

I. ASCENDING BRANCHES.

§ 1861. The ascending branches are the *temporal* and the *malar* rves (*N. temporales et malares*). Chaussier terms them collectively e *temporo facial branch.*

a. Temporal nerves.

§ 1862. We find,

5th, 6th, 7th. Two or three *temporal* nerves, which give some small aments to the parotid gland, ascend on the malar bone, anastomose tween them with the superficial and deep temporal branches of the omaxillary nerve posteriorly, and with the frontal and lachrymal gs of the first branch of the trifacial nerve, are distributed on the nporalis muscle, and send ramifications to the skin of the temples, that of the anterior part of the external ear, the anterior auricular

muscle, and the external and the upper part of the orbicularis palpebrarum muscle.

When only two temporal nerves exist, the anterior is larger than the other.

b. Malar nerves.

§ 1863. 8th and 9th. These are usually two nerves; they proceed more forward and upward than the preceding, and passing on the malar bone, they are distributed in the skin which covers this bone and the external edge of the orbit, in the outer part of the eyelids, in the external and lower part of the orbicularis palpebrarum muscle, finally in the posterior part of the zygomatici muscles.

II. ANTERIOR BRANCHES OR BUCCAL NERVES.

§ 1864. There are usually three, more rarely two, anterior branches or *buccal* nerves (*N. buccales*).

The central one is the largest.

They go almost directly forward on the upper and middle portion of the masseter muscle, beyond its anterior edge. The middle is situated directly on the excretory canal of the parotid gland.

The superior, passing under the zygomatici muscles, to which it gives filaments, ascends towards the lower eyelid, and goes to the inner angle of the eye, where it often anastomoses with the infratrochlear nerve given off by the fifth part.

The central divides into ascending and anterior twigs.

The ascending twigs arrive at the lower part of the obicularis palpebrarum muscle, the muscles of the sides of the nose, and the skin which covers them, anastomose with some filaments of the infraorbitar nerve which come from the fifth pair, particularly with the external, and terminate in the levator muscles of the upper lip, the orbicularis oris, and the skin of the upper lip.

The inferior go directly forward, are distributed in the buccinator muscle, the skin of this region and that of the lower lip. They anastomose with the buccal nerve which comes from the third branch of the fifth pair.

III. DESCENDING BRANCHES.

§ 1865. The descending branches, *cervico-faciales*, Ch., arise from the lower and smaller trunk, which commonly anastomoses at its origin by some filaments with the superior.

This trunk generally divides into two branches.

The superior goes forward on the lower part of the masseter muscle, anastomoses with the inferior buccal nerve, and is distributed in the skin of the lower lip, the depressor labii inferioris, and the buccinator muscle.

The inferior descends towards the lower angle of the jaw, and divides near the angle of this bone, into a superior and an inferior twig.

The superior twig, the *marginal* nerve (*N. marginalis*), proceeds above and along the edge of the lower jaw, goes forward and upward, distributes its filaments in the muscles which depress the lower lip and in the skin of the chin, and anastomoses with the inferior labial nerves of the third branch of the trifacial nerve.

The inferior divides in turn into two or three ramuscules, the *superior cutaneous cervical* or *submaxillary* nerves (*N. subcutanei colli superiores*), which descend under the jaw, are distributed in the upper part of the skin of the neck and in the platysma myoides muscle, and anastomose frequently with the ascending twigs of the anterior branch of the third cervical nerve.

VII. EXTERNAL MOTOR NERVE.

§ 1866. The *external motor* nerve, the *sixth pair*, the *external oculo-muscular* nerve (*N. oculo-muscularis externus*, s. *posterior*, s. *abducens*, s. *par sextum*),* is flat, and arises by two very distinct roots, an nternal and an external, which is usually four times the size of the ormer, from the upper extremity of the pyramid, from the posterior edge and the posterior extremity of the lower face of the annular protuberance, about two lines from the median line, and four or five lines nside of the facial nerve. From the inferior face of the annular protuberance only the inner root generally arises, which sometimes does ot extend to the posterior edge, but terminates two lines from this dge, and arises only from the external face of this protuberance, although we cannot follow it farther either backward or forward. The xternal root generally arises also from the anterior extremity of the yramid. These two roots, particularly the internal, are formed of everal fasciculi, which are easily detached from each other.

It is very rare that the internal root is the larger,† or that the laments by which the nerve arises do not unite in two distinct roots.

Sometimes the nerve arises only from the pyramid. Not unfreuently it comes in part from the olivary body and the transverse band hich is often found between the summits of the two pyramids.‡

We can, however, generally demonstrate particularly by comparave anatomy, that it arises from the medulla oblongata between the livary bodies and the pyramids, much lower than it comes from them, nd that the different filaments coming from the olivary bodies, the nall transverse striæ, and the pons Varolii, are either supplementary, as is true particularly of those from the annular protuberance,

* Zinn, *Desc. oculi humani*, Gottingen, 1755, tab. vi.
† We have rarely seen this. Vicq-d'Azyr (*Mém. de Paris*, 1781, p. 589) observes so that this arrangement is rare.
‡ Vicq-d'Azyr, *loc. cit.*, p. 589.

appear to be distinct roots only, because the fibres of the principal root of the nerve are separated from each other at their upper part by the posterior fibres of the pons Varolii.*

The two roots generally unite before passing through the dura-mater: sometimes, however, each passes through a special opening in this membrane and also proceeds three or four lines and even glides under a special fibrous bridge entirely distinct from the dura-mater before they join. In the cases where we have seen this arrangement it has *always* appeared on the left side *alone*, and the external fasciculus was the smaller.

These facts, compared with those adduced by Sœmmerring, seem much in favor of the opinion that the ganglionnary nerve comes from the centre of the nervous system, and that the cerebral nerves appear to be more numerous than they truly are by the enlargement of some branches. If proved that the external motor nerve always divides on the left side, it would be important on account of the analogy which is establishes with the vascular system.

On leaving the encephalon the nerve becomes fibrous, is covered with a neurilemma and goes directly forward and outward, passes through the dura-mater below the posterior clinoid process, enters the cavernous sinus, within which it is attended a short distance by the arachnoid membrane, being separated from the blood by the inner membrane of the sinus, and is situated on the outside of the internal carotid artery to which it is attached by compact cellular tissue. In passing above the anterior orifice of the carotid canal it anastomoses with the ganglionary nerve by some filaments which form an acute angle with its trunk. Farther forward it communicates also by a filament with the spheno-palatine ganglion, or the recurrent nerve of the second branch of the trifacial nerve. It goes to the orbit through the sphenoid fissure through a special opening in the dura-mater, enters this cavity between the fasciculi of the rectus oculi externus muscle, intimately united in this place with the common motor nerve and the nasal nerve of the first branch of the trifacial nerve, and coming on the inside of the rectus externus muscle is entirely distributed to it.

The external motor nerve goes then only to one muscle. It very rarely gives off the nasal branch of the fifth pair,† but more frequently sends a filament to the opthalmic ganglion.‡ This latter arrangement makes the transition from that commonly found in the first. This anastomotic filament, however, undoubtedly belongs at least in part to the ganglionnary system.

* Gall, *loc. cit.*, p. 204.
† Otto, *Seltne Wahrnehmungen*, 1816, p. 108.
‡ Petit, *Mém. de Paris*, 1727.

VIII. TRIFACIAL NERVE.

§ 1867. The *trifacial* nerve, the *fifth pair*, (*N. trigeminus*, s. *divisus*, s. *mixtus*, Gall, s. *par quintum nervorum*),* is very large: it appears about six lines before the posterior edge of the inferior prolongation of the cerebellum, three behind the anterior edge of this prolongation, and nine from the median line of the pons Varolii. There it is manifestly composed of three more or less distinct roots, a posterior, a central, and an anterior. The posterior is situated farther backward and higher than the central, and the anterior below and on the inside of it. These roots were first correctly described by Santorini,† and after him by Wrisberg,‡ Palletta,§ and Niemeyer.‖

§ 1868. The central root is always much larger than the other two, for it is more than a line and a half in diameter after it emerges, while each of the others is only about half a line. Its fasciculi are more numerous: but they are smaller than those of the other two roots.

At the place where it emerges it is a little depressed from above downward, but soon enlarges, becomes round, and again contracts.

The fibres of the annular protuberance evidently separate at their base, so that we may judge, from a superficial examination, that the root does not arise in this place but from a deeper part.

This middle root is composed of thirty or forty fasciculi of various sizes. The number of filaments which form these fasciculi is about one hundred: some authors assert less; but they probably have described the faciculi simply as filaments, or have neglected to decompose several of them.

It is principally by following the central root that we can demonstrate very evidently that the nerve arises from a deeper part than where it leaves the annular protuberance. Santorini has stated perfectly its true origin; ¶ his observations have been confirmed and

* J. F. Meckel, *De quinto pare nervorum*, Gottingen, 1748.—A. B. R. Hirsch, *Paris quinti nervorum encephali disquisitio anatomica*, Vienna, 1765.—H. A. Wrisberg, *Observationes anatomicæ de quinto pare nervorum et de nervis, qui ex eodem duram matrem ingredi falso dicuntur*, Gottingen, 1777.—A. C. Bock, *Beischreibung der fünften Nervenpaares und seiner Verbindung mit andern Nerven, vorzüglich dem Gangliensystem*, Meissen, 1817.—G R. Treviranus, *Sur les nerfs de la cinquième paire, considérés comme organes ou conducteurs de sensations*; in the *Journ. compl. du dict. des sc. méd.* vol. xv. p. 207 —Magendie, *Sur les fonctions de la cinquieme paire de nerfs*; in the *Journ. de phy. exp.*, vol. iv. p. 176 and 302.

† *Obs. anat.*, Venice, 1724, p. 65.

‡ *Loc. cit.*

§ *De nervo crotophilico et buccinatorio*, Milan, 1784.

‖ *De origine paris quinti nervorum cerebri*, Hales, 1812.

¶ *Loc. cit.*, p. 65. The honor of this discovery then belongs to Santorini. Niemeyer seems to attribute it to Winslow, and is consequently wrong, for the *Anatomy* of Winslow appeared first in 1732, while Santorini's observations were published in 1724.

rendered still more exact by the labours of Winslow,* Sœmmerring,† Gall,‡ and Niemeyer.§

Here also the posterior part and the proper origin of the nerve are covered by the considerable development of the cerebral parts. On leaving the place where it appears, it enters from without inward, from before backward, and from below upward in the fissure of the central prolongation of the cerebellum, and is more or less completely divided into several cords by the transverse fibres of the annular protuberance, thus comes behind the union of the three peduncles of the cerebellum directly below the floor of the fourth ventricle, passes under the posterior prolongation of the cerebellum, almost the length of the external edge of the annular protuberance, and proceeds towards the groove between the restiform and the olivary bodies ; its strongest root arises there partly from the groove and partly from the olivary eminences.

From this point to where it passes between the posterior and lateral prolongations of the cerebellum it is not fibrous, and is surrounded by grey substance ; but from this second point to its emerging from the annular protuberance it is formed of very apparent fibres, and is surrounded by a thin membrane. In its whole extent from its origin to a little before its emerging on the external face of the inferior prolongation of the cerebellum it gradually becomes thicker, but before leaving the pons Varolii it slightly contracts and enlarges considerably after emerging.

The fasciculi of the nerve are then more distinct and surrounded with neurilemma, and occupy the whole circumference of the pons Varolii. They enlarge partly by the separation and partly by the increase of their substance. When once emerged, the nerve is at first round but gradually becoming flatter, goes forward towards the upper end of the petrous portion of the temporal bone. At first it is loose in the skull, being loosely surrounded by a broad prolongation of the arachnoid membrane, but at the upper edge of the petrous portion of the temporal bone it enters a rounded and oblong sheath of the dura-mater, which generally is entirely separated from the cavernous sinus. This sheath is at first loose, but afterwards is placed strongly on its surface. It thus goes from before downward and from behind forward on the anterior face of the petrous portion of the temporal bone.

In this course the trifacial nerve examined externally seems formed only by fasciculi placed one at the side of another. These fasciculi, however, communicate their whole extent by small intermediate filaments. This union and the ramification of fasciculi which results from it, become more and more marked from behind forward, and for about a line and a half to two lines the breadth of the fasciculi divide into

* *Exp. anat.*, 1732 vol. iv. p. 182.
† *Loc. cit.*, p. 267
‡ *Ueber das Organ des Seele*, Koenigsberg, 1796, p. 36.
§ *Loc. cit.*, p. 211.

very minute filaments, and interlace perpetually with each other near its anterior extremity. The trunk of the nerve, which here touches outward the last curve of the internal carotid artery, anastomoses with some filaments of the great sympathetic nerve.

The anterior extremity of this large principal root suddenly differs in appearance from the other parts, and the different branches of the nerves.

In fact at the anterior extremity of the upper face of the petrous portion of the temporal bone it forms a semicircular prominence, the concave edge of which is turned upward and backward, and the convex edge downward and forward. This prominence, which reaches beyond the trunk of the nerve in every direction, is six to ten lines long from before backward, one broad from within outward, and a line and a half high. It is termed the *semilunar ganglion* or *gangliform plexus* (*ganglion semilunare, plexus gangliofo rmis,* Vieussens; *intumescentia ganglio affinis,* Scarpa; *plexus retiformis,* Santorini; *tænia nervosa,* Haller; *intumescentia semi-lunaris,* Wrisberg; *Agger lunatus,* Neubauer; *Armilla,* Malacarne). It is transparent and reddish, and for about a quarter to half a line has no determinate texture, if we except some filaments which pass over its two faces, particularly the inner part of the inferior: but it then reassumes its fibrous appearance, so that in the mode directly the opposite of that over the plexus the filaments unite from above downward in larger threads, and thus produce fasciculi, still forming a trunk from one and a half to two lines broad, which immediately divides into three principal branches, the upper of which forms with the crural a very acute angle, and the latter a slightly obtuse angle with the posterior. The branches, the fasciculi of which still interlace with each other, are at first broad, but they gradually become round in approaching the openings through which they pass.

The plexiform filaments of the nerve are not generally continuous with the inferior, but terminate in a channel grooved on the upper and concave edge of the ganglion. The inferior arises from all the circumference of the ganglion, and most generally extend to the upper and concave edge externally. The substance of the ganglion homogeneous internally, and precisely similar to that of the proper nervous ganglions.

§ 1869. The *small roots of the trifacial* nerve do not contribute to form the prominence of the ganglion, although there is on the lower face of this latter, and of the large root, a groove formed by their passage.

The *superior* penetrates through a special fissure into the inferior prolongation of the cerebellum from one fourth of a line to two lines distant from the great middle root. When the two roots are very near each other they seem to enter through the same fissure: but in attentively examining we perceive this is rarely the case, even if it ever happens. The direction of the superior root in the inferior prolongations of the cerebellum is the same as that of the preceding, which proceeds below

it; we however cannot trace the former as far. Soon after emerging, it turns on the upper face and the inner edge of the large root, arrives at its lower face, and continuing to pass on, it goes gradually outward where it reunites, after passing about half an inch, with the small inferior roots. It is formed of from three to six fasciculi of different sizes.

The *small inferior root* is generally nearer the central than the superior, being often only a fourth of a line and seldom more than one line distant from it, and the rule mentioned by Palletta, that they are always several lines distant, cannot be admitted. They often evidently arise from the same groove. The part of the small inferior root which is contained in the cerebral substance always proceeds below the large in the same direction with it, and less distant from it than is the upper root. It is generally formed of a greater number of fasciculi than the upper, as there are about from six to eight. It leaves the annular protuberance on the lower face of the large root, and reunites with the small superior root in the manner stated, most generally, three or four lines behind the ganglionnary prominence of the large root. The trunk of the *temporo-buccal* nerve (*N. crotaphito-buccinatorius*), formed by this union, passes first under the large root, then under the ganglionnary prominence and the third branch of the fifth pair, thus goes outward and forward, and anastomosing in this course only by some inconstant filaments, first with this trunk, then with the third branch of the fifth pair, often but not always, enlarges longitudinally under the plexiform ganglion, and after passing through the foramen rotundum of the basilar bone proceeds to form the temporal and buccal nerves.

These two small roots form the small portion of the fifth pair, which is whiter and harder than the large.

Their separation with the ganglion formed by the large portion is extremely curious, as it presents a repetition of the formation peculiar to the nerves of the spinal marrow.

A. FIRST PRINCIPAL BRANCH.

§ 1870. The *first branch*, the *superior* or *ophthalmic branch of the fifth pair*, (*R. primus*, s. *superior*, s. *ophthalmicus*),* is much smaller than the other two, and arises from the upper part of the ganglion. Its direction is from below upward and from behind forward on the outer side of the cavernous sinus towards the orbit, into which it penetrates from within outward, on the outside of the common motor and below the superior motor nerve.

In this course it gives off no branches, except nearer or farther from its origin a tolerably constant twig which unites to the superior motor nerve, and another less constant which goes to the ganglionnary nerve.

* Rinn, *Descriptio oculi humani*, tab. vi.—Sœmmerring, in Demours, *Traité des maladies des yeux*, vol. iv., p. 32, pl. vi., fig. 1.

But it is united in all its extent by very compact cellular tissue with the superior motor nerve.

Just before entering the orbit it generally divides into two and more rarely into three twigs, which are the *nasal*, the *lachrymal*, and the *frontal* nerves. In the first case, the second branch, which is larger than the other, is the common trunk of the lachrymal and frontal nerves.

1st. The *nasal* or *naso-ciliariy* nerve (*N. naso-ocularis*, s. *naso-ciliaris*), which in respect to size is between the other two, anastomoses posteriorly with some filaments of the great sympathetic nerve, and divides into two branches generally before entering the orbit.

The *external* branch (*R. ciliaris*, s. *ad ganglion*) is the smaller, and goes to the *lenticular* or *ciliary ganglion* (*ganglion lenticulare*, s. *ciliare*), which is situated on the outside of the optic nerve and forms its long root. Sometimes it anastomoses previously by one or two filaments with the common motor nerve.* It rarely gives off a ciliary nerve.

The *internal* branch is larger and proceeds forward and inward on the optic nerve, with which it is connected. It not unfrequently gives off some ciliary nerves which proceed along the optic nerve to the eye and enter its capsule at its posterior part, proceed between the fibrous envelop and the choroid membrane to the iris, in which they are distributed with analogous but more numerous filaments which come from the lenticular ganglion, forming with them from five to ten nerves which generally divide again into two, more rarely into three fasciculi, which we shall describe when speaking of the eye. Several filaments from the ganglionnary nerve enter the ganglion.†

The nerve then passes below the rectus oculi superior and obliquus major muscles, continues to proceed inward and forward, situated against the internal wall of the orbit, and soon divides into two branches, the *ethmoidal* and the *infra-trochlear* nerves.

The *ethmoidal* or *internal nasal* nerve (*N. ethmoidalis*, s. *nasalis*, Winslow, s. *ophthalmicus*, Willis, s. *nasalis internus*), re-enters the skull through the internal and anterior orbitar foramen, afterwards emerges from this cavity through one of the anterior foramina of the cribriform plate of the ethmoid bone, proceeds to the nasal fossa, sends filaments to the mucous membrane of the superior turbinated bone and of the septum, sends others to that of the frontal sinus, then glides in a groove of the nasal spine of the frontal and of the proper nasal bones, descends along the anterior edge of the cartilaginous septum of the nose to the nasal fossæ, emerges, and terminates at the tip of the nose sending filaments to its alæ, at the end of which it anastomoses

* Bock, *loc. cit.*, p. 11.

† Ribes, *Sur quelques parties de l'œil*; in the *Mém. de la soc. méd. d'ém.*, vol. iii., p. 86.—Bock, *loc. cit.*, p. 12.

with some twigs of the second branch of the fifth and the seventh pairs.*

The ethmoidal nerve sometimes divides into an anterior and a posterior trunk, the latter of which passes through the internal and posterior orbitar foramen, and remains in the nasal fossa.†

The *infra-trochlear* or *external nasal* nerve (*N. infra-trochlearis*), advances below the rectus and obliquus superior oculi muscles, along the inner wall of the orbit, passes directly below the pully, and gives off a small filament to the mucous bursa in this place, leaves the orbit, and divides in the internal angle of the eye into two principal branches, a superior and an inferior. These branches soon subdivide into twigs by which the nerve is distributed in the tunica conjunctiva, the caruncula lachrymalis, the lachrymal sac, the orbicularis palpebrarum and the frontalis muscles, and the skin of the back of the nose. It anastomoses above with the supra-trochlear nerve, then with some filaments of the facial nerve, and farther forward with the second branch of the fifth pair.

Sometimes the long root of the lenticular ganglion does not come from the nasal nerve, but from the third pair. Analogous to this arrangement, but much more rare, is the case where the nasal nerve comes from the sixth ‡ and not from the fifth pair.

2nd. The *frontal* branch or nerve (*N. frontalis*), the largest of the three branches of the ophthalmic nerve, proceeds between the other two from behind forward and from without inward on the levator palpebræ superioris muscle directly below the arch of the orbit. It is at first intimately united with the superior motor nerve.

At about its centre it sends off inward and forward a small branch which anastomoses with the infra-trochlear nerve, and which sends filaments into the frontal sinus, either directly, or indirectly by a small ganglion.

It then sends off a larger filament, the *supra-trochlear* nerve (*N. supra-trochlearis*), which proceeds along the internal wall of the orbit, passes above the pully of the obliquus major muscle, and emerges from the cavity of the orbit. This nerve, called also the *internal frontal* nerve, is reflected from below upward, distributes its twigs in the corrugator supercilii muscle, the internal and upper part of the orbicularis palpebrarum, the frontalis muscle and the skin which covers it, and anastomoses with some filaments of the infra-trochlear and the proper frontal nerve.

The continuation of the trunk, the proper frontal nerve, gives off no branch within the orbit, leaves this cavity sometimes in one root but sometimes divided into several, although one or more supra-orbitar foramina, is soon reflected from below upward on the upper edge of the orbit, and is distributed in the skin of the forehead and the vertex.

* Hunter, *Observations on different parts of animal economy*, London, 1792.—*A description of some branches of the fifth pair of nerves*, p. 265.
† Bock, *loc. cit.*, p. 18.
‡ Otto, *Seltne Beobachtungen*, Breslau, 1816, p. 108.

3d. The *lachrymal* nerve, (*N. lachrymalis*) which is between the other two in size, and is the most external of the three twigs of the first branch of the fifth pair, goes forward and outward, being also situated against the orbitar plate, and soon divides into an external and an internal branch.

The *external* reunites with a twig of the subcutaneous malar nerve, which comes from the second principal branch of the fifth pair. From this trunk we generally see a filament depart which is sometimes double, and which passing directly to the anterior extremity of the inferior orbitar fissure, between the malar and sphenoid bones, goes outward in the temporal fossa, where it anastomoses with a malar branch of the facial nerve, more rarely with the superficial temporal nerve which comes from the second principal branch of the fifth pair.*

The external branch sometimes sends a filament to the ciliary nerves, which come directly from the nasal nerve.†

The *internal* branch divides into several twigs, which anastomose with each other like a plexus, and enter the lachrymal gland.

These twigs are not distributed entirely in the gland. Some, after passing through it, come outwardly, where they are distributed, partly in the external part of the orbicularis palpebrarum muscle, partly in the integuments of the malar region, and anastomose with some filaments from the posterior branches of the facial, the frontal, and the subcutaneous malar nerves.

B. SECOND PRINCIPAL BRANCH.

§ 1871. The *second principal branch of the fifth pair*, the *middle branch*, the *superior maxillary* nerve (*R. quinti paris secundus*, s. *medius*, s. *N. maxillaris superior*),‡ is between the other two in its situation and volume. It arises from the anterior part of the ganglionnary plexus; it goes almost directly forward, or at least a little oblique from below upward, gives off no branch within the skull, though it sometimes anastomoses there with a filament of the ganglionnary nerve,§ and emerges from this cavity outward and forward through the great foramen rotundum of the sphenoid bone. It is flat, but after emerging it becomes round.

Some distance from the place where it leaves the skull, the superior maxillary nerve gives off a small branch, the *subcutaneous malar* nerve (*N. subcutaneous malæ*), which reascends in the spheno-maxillary fissure. This branch enters into the orbit below the rectus externus oculi muscle, and anastomoses by one or more filaments with

* Bock, *loc. cit.*, p. 19.
† Bock, *loc. cit.*, p. 20.
‡ J. F. Meckel, *De quinto pare nervorum*; in Ludwig, *Opp. min.*, Gottingen, 7.—A. Scarpa, *Annot. acad.*, l. ii., Modene, 1779. cap. iv. v. vi. tab. i. ii.
§ Laumonier, in Roux, *Journ. de méd.*, vol. xciii. p. 259.

the external twig of the lachrymal nerve. It sends off, farther forward, one or more ramifications, which enter into the lachrymal gland; some of them remain in its tissue, while others, after passing through it, emerge from the orbit and are distributed in the orbicularis palpebrarum muscle and the skin of the cheek, where they communicate with some filaments of the facial nerve and of the third principal branch of the fifth pair. Finally, the subcutaneous malar nerve emerges from the orbit through the malar foramen, sometimes in one trunk, and sometimes divided into several filaments. It is distributed on the face to the lower part of the orbicularis palpebrarum muscle, and also to the skin of the malar region, and communicates with the twigs of the facial and infraorbitar nerves.

The superior maxillary nerve then divides into two much larger and nearly equal branches, which proceed almost directly from above downward. They are the *pterygo-palatine* and the *infraorbitar* nerves.

The *pterygo-palatine* nerve (*N. pterygo-palatinus*) sometimes forms a single trunk, sometimes arises by two or three distinct filaments, which become the roots of a small rounded triangular or cordiform ganglion, situated on the outside of the spheno-palatine foramen, and termed from its discoverer, the *ganglion of Meckel* (*G. Meckelii*)* and also the *spheno-palatine* ganglion (*G. spheno-palatinum*). The *recurrent* and *palatine* nerves come from this ganglion.

The branches coming from the pterygo-palatine ganglion vary according as the spheno-palatine ganglion does or does not exist.

If it exists, the *upper anterior nasal* nerves partially arise from the trunk of the pterygo-palatine nerve, partly from the palatine nerve, and the naso-palatine nerve comes from the pterygo-palatine.

Several small branches come from the trunk of the pterygo-palatine nerve, and from the spheno-palatine ganglion when they exist.

First arises a filament which enters the sphenoidal sinus, or which, when it is very much developed, passes through this cavity and goes to the external motor nerve, with which it anastomoses;† sometimes it sends ramifications to the sphenoidal sinus, and also to the posterior and most superior part of the septum of the nasal fossæ.

Next come four or five filaments which are a little larger; they pass through the dura-mater, which is extended on the pterygo-palatine foramen, are distributed in the mucous membrane which lines the posterior part of the upper and middle turbinated bones of the nose, and anastomose with the ramifications of the olfactory nerve. They are the *upper anterior nasal* or the *spheno-palatine* nerves (*N. nasales superiores et anteriores*). Farther on is the *nerve of the septum*, which will be described more properly after the naso-palatine nerve, and the

* J. F. Meckel, *Observation anatomique sur un nœud ou ganglion du second rameau de la cinquieme paire des nerfs du cerveau nouvellement decouvert avec l'examen physiologique du veritable usage des nœuds ou ganglions des nerfs*; in *Mem. de Berlin*, 1749. p. 84, 103. tab. iii.

† Bock, *loc. cit.*, p. 26.

upper posterior nasal nerves, which, however, are more frequently branches of the recurrent nerve.

The pterygo-palatine nerve then divides in the summit of the pterygo-palatine fossa, into a *recurrent* and a *descending* branch.

The *recurrent* branch, the *pterygoid* or *vidian* nerve (*N. quinti recurrens*, s. *anastomoticus*, s. *pterygoideus*, s. *vidianus*), is so termed from its direction; for it goes backward, enters into the pterygoid foramen, and anastomoses by several filaments with the facial and great sympathetic nerves.

This nerve gives off first inward and downward, two or three filaments termed the *posterior* and *superior nasal* nerves (*N. nasales posteriores superiores*), which sometimes unite in a small trunk, termed by Bock, the *pharyngœal* nerve (*R. pharyngœus*). These nerves emerge sometimes through the lower part of the spheno-palatine foramen, sometimes pass through the inner wall of the pterygoid canal, penetrate inward through the pterygoid process, and are distributed in the posterior part of the mucous membrane of the nose, where they anastomose with the ramifications of the olfactory nerves in the muscles of the velum palati, the skin of the soft palate, and around the anterior orifice of the Fallopean tube.

The external part of the nerve, which is remarkable for its softness and reddish colour, then divides, before leaving the pterygoid canal into two branches, which sometimes remain distinct to the ganglion, and by which it terminates.

These two branches are the anastomotic nerves. The smaller *superior* or *superficial* nerve is the *superficial petrous* nerve (*N. petrosus superficialis*). It proceeds generally single, seldom divided, through the fibro-cartilage, situated between the sphenoid bone and the petrous process, goes backward, upward, and outward, under the third principal branch of the fifth pair, in a groove on the upper face of the petrous process, leaves this groove and enters the Fallopean canal, anastomoses here with the facial nerve which passes through it, and sometimes sends filaments to the branches of the ganglionary nerve which surround the upper part of the carotid artery like a plexus.*

The *inferior* or *deep*, the larger, proceeds in the same direction as the recurrent nerve, emerges from the posterior extremity of the pterygoid canal through the fibro-cartilage, between the sphenoid bone and the petrous process, goes outward and backward, passes through the dura-mater, and goes into the carotid canal, where it anastomoses with the upper extremity of the ganglionary nerve, conjointly with a filament of the sixth pair, thus forming a very constant and very evident anastomosis between the fifth pair and the great sympathetic nerve. The differences sometimes observed in this respect will be more in place in the description of the great sympathetic nerve. In fact, it is probably more correct to consider the deep branch of the recurrent nerve as a ramification of this latter.

* Bock, *loc. cit.*, p. 28.

The *descending* branch or the *palatine* nerve (*N. palatinus*) is much larger than the recurrent, and is distributed to the middle and lower part of the mucous membrane of the nose, and also to the membrane of the palate. It is then more properly termed the *naso-palatine* nerve (*N. naso-palatinus*).

From this, or from the spheno-palatine ganglion, or finally from the trunk of the pterygoid-palatine nerve, arises first the *nerve of the septum of the nose* (*N. septi narium*), which Scarpa* less properly terms the *naso-palatine* nerve (*N. naso-palatinus*).†

This nerve enters the nose with the anterior and superior nasal nerves, through the spheno-palatine foramen, proceeds from without inward, passing before the sphenoidal sinus towards the septum on which it descends from behind forward, between the periosteum and the mucous membrane, to the anterior palatine foramina, farther forward on the left than on the right side, and thus arrives at the membrane of the palate. In passing through the palatine canal the nerves of the two sides unite, sometimes form a small prominence termed the *naso-palatine* ganglion (*G. naso-palatinum*), and expand on a prominence situated below the anterior palatine foramen.

The palatine nerve then divides into a larger anterior branch, the continuation of the trunk, and two or three smaller and posterior, all of which descend into the pterygo-palatine fossa. These branches are the *great* and *small palatine* nerves (*N. palatina major et minores*). They sometimes arise directly from the ganglion, or even, as is true particularly of the smallest, from the second principal branch.

From the anterior part of the great palatine nerve arise first the *middle* and *inferior posterior nasal* nerves (*N. nasales posteriores medii et inferiores*)‡.

The *posterior middle nasal* nerve soon divides into two branches, which are sometimes separate at their origins. The superior goes directly forward in the mucous membrane of the middle turbinated bone. The second goes to the upper part of that of the inferior turbinated bone.

The *posterior inferior nasal* nerve arises much lower, opposite the posterior extremity of the lower turbinated bone, towards which it proceeds directly, and sends its filaments into the mucous membrane which lines the inner face of this bone anteriorly.

These two nerves anastomose with the ramifications of the olfactory nerve.

The anterior branch of the great nasal nerve sends directly backward a small twig, which passes through the pterygoid process in a special canal, and is distributed to the glandular substance of the soft palate.

* *Loc. cit.*, cap. v. *De nervo palatino.*
† Scarpa, *loc. cit.*, tab. i.—Hunter, *Observations on different parts of the animal economy*, tab. xvii.
‡ Cloquet, *loc. cit.*, vol. ii. p. 687.

The branch, the fasciculi of which separate from each other, goes forward and downward in the pterygo-palatine canal, and comes through the posterior palatine foramen to the lower face of the bony palate, where it immediately divides into three or four considerable branches, which proceed between the mucous membrane and the periosteum, along the inner face of the alveolar processes opposite the teeth, and are distributed in the gum.

The two or three *small palatine* nerves descend behind the great palatine nerve, first in the pterygo-palatine fossa, then lower in small special canals of the petrous portion of the temporal bone, on emerging from which they enter into the amygdalæ, the palato-staphylinus muscle, the muscular and glandular substance of the soft parts of the palate and the uvula.

§ 1872. The *infraorbitar* nerve (*N. infraorbitalis*), the second of the two branches in which the superior maxillary nerve divides, is directed from behind forward, from within outward, and from above downward, in the spheno-maxillary fissure, and goes to the infra-orbital canal.

But before entering into this canal, it sends off a considerable branch called the *dentar* or *posterior superior alveolar* nerve (*R. dentalis*, s. *alveolaris posterior superior*). This nerve divides sometimes even at its origin, sometimes afterward, into two branches, an anterior which is smaller, and a posterior which is larger.

The *posterior* descends on the posterior part of the external wall of the maxillary sinus, below the temporalis muscle, which enters into this cavity through its posterior wall, is distributed in its mucous membrane,* and there anastomoses with the anterior dentar nerve. It terminates by some superficial ramifications which go to the buccinator muscle, and by deeper twigs which enter into small canals grooved in the posterior part of the body of the superior maxillary bone, and penetrates into the roots of the three large posterior molar teeth. Each root receives one of them. We see one of them also between each two molar teeth, which goes into the gum.

The *anterior* branch is distributed principally in the upper and posterior part of the buccinator muscle.

After giving off the upper and posterior dentar nerve, the infra-orbitar nerve enters into the infra-orbitar canal.

In passing through this canal it usually gives off, sometimes sooner and sometimes later, several branches, but always one at least, which is larger than the others, even when they exist; these are the *anterior dentar* nerves (*N. dentales anteriores*) which enter into the superior maxillary bone, send some filaments into the nose at the anterior part of the inferior turbinated bone, anastomose by several filaments with the posterior dentar nerves, pass forward on the roots of the anterior teeth, and terminate by ramifications which go to the in-

* Bock asserts that the nerve is not distributed to the membrane of the maxillary sinus; but we have several times clearly seen filaments arising from it.

cisors, the canine, and the anterior molar teeth, and to the gum. Those which belong to the incisors and the canine teeth arise directly from the anterior dentar nerve; those of the anterior molar teeth from the union of this nerve with the posterior dentar nerve.

The infraorbitar nerve then emerges from the canal through the infraorbitar foramen, within which it divides into two principal branches, an internal and an external, and sometimes even in all the other subordinate branches. It thus comes on the face, where it divides into a considerable number of ramifications, which terminate in the skin and the muscles of the nose and upper lip, and anastomose with those of the first principal branch of the fifth pair, and also with some filaments of the facial nerve.

The two principal branches usually subdivide into six or seven twigs, which may be distinguished into *superior*, *anterior*, and *inferior*.

1st. *Superior* branch. There is usually only one superior twig, the *inferior palpebral* nerve (*N. palpebralis inferior*). This nerve, the first given off by the infraorbitar nerve, from which it is sometimes separated even within this canal, and which often emerges through a special foramen situated more internally than the infraorbitar, immediately ascends from without inward towards the lower part of the orbicularis palpebrarum muscle, and divides into an external and an internal twig.

The *external* goes outward towards the external angle of the eye, on the lower part of the orbicularis palpebrarum, and gives off filaments to this muscle. It anastomoses with those of the internal twig, and with the temporal branches from the facial nerve.

The internal goes to the inner angle of the eye, gives a twig to the skin of the nose which descends to the end of this organ, where it anastomoses with the nasal twig of the first principal branch of the fifth pair. It afterwards anastomoses in the lower eyelid with the external twig and with a filament of the infra-trochlear nerve, and terminates in the orbicularis palpebrarum muscle, the integuments of the lower eyelid, the caruncula lachrymalis, and the lachrymal sac.

2d. *Anterior* or *nasal twig*. The twigs which go forward, and also at the same time a little outward, are the *superficial* or *cutaneous nasal* nerves (*N. nasales superficiales*), which may be distinguished into an *internal superior*, and an *external inferior*.

The *internal superior*, generally the smaller, is reflected upward under the levator palpebræ superioris muscle, often gives origin to the preceding, and then divides into two or three filaments which proceed forward below this muscle along the centre of the nose, send their ramifications into the levator labii superioris alæque nasi, and the depressor alæ nasi muscles, and the integuments of the middle and inferior parts of the nose. They extend to the back and tip of this organ, and anastomose in the latter place with the nasal twig of the first principal branch of the fifth pair.

The *external* and *inferior* descends under the levator labii superioris muscle, often sends an ascending filament to the lower eyelid and to the lower part of the orbicularis palpebrarum muscle, then continues its course from above downward, often receives a filament from the preceding, goes forward to the ala of the nose above the levator abii superioris alæque nasi muscle, sends ramifications to this muscle and to the middle and upper parts of the orbicularis oris, and terminates at the lower part of the septum and of the top of the nose, where t anastomoses with the nasal twig of the first principal branch of the ifth pair.

3rd. *Descending* or *labial twigs.* The descending twigs are generally three or four *superior labial* nerves (*N. labiales superiores*), they ucceed one another from before backward. They are distinguished nto *internal*, *middle*, and *external.* All descend from before backard, covered by the levator labii superioris muscle, are distributed n this muscle, the skin of the upper lip, the corresponding part of ie orbicularis oris, and the lower part of the zygomatici and the buccinator muscles. They even penetrate through the orbicularis oris uscle, and go to the buccal membrane and the glands of the upper p.

4th. We frequently find also an external twig of the infraorbitar rve, the *external palpebral* nerve. This very small twig passes rough the levator labii superioris muscle, goes outward, where some its filaments are distributed in the orbicularis palpebrarum mus-, and others anastomose with filaments of the facial nerve.

C. THIRD PRINCIPAL BRANCH.

§ 1873. The *third principal branch*, the *inferior* or *posterior branch the fifth pair*, the *inferior maxillary* nerve (*R. quinti paris tertius, s. erior, s. posterior, s. nervus infra-maxillaris*),* which is by far the gest, arises from the lower and posterior part of the ganglionnary xus, and is formed principally by the small anterior portion, whence llettа† considers it a distinct nerve. It is the shortest of the three hin the skull, and goes from above downward, and slightly also ward and outward, and enters the round foramen of the sphenoid ie, after anastomosing in this course with some inconstant filaments, h the cavernous ganglion of the sympathetic nerve.‡

The *inferior maxillary* nerve is distributed to the muscles, the guments, and the teeth of the lower jaw, the lower lip, the lower vary glands, and the tongue.

t is covered where it emerges from the cranium, by the pterygoideus ernus muscle, and soon divides into two large branches, an upper anterior, and a lower and posterior. This bifurcation however is

A. F. L. Fitzau, *De tertio ramo paris quinti nervorum cerebri, s. nervi maxil- inferiori.* Leipsic, 1811.

De nervis crotaphitico et buccinatorio, Milan, 1784.

Laumonier, *loc. cit.*—Munniks, *De origine nervi intercost.* In *Obs. var.*, Gro- n, 1805.

not constant, for sometimes the twig formed by the two branches comes directly from the trunk.

§ 1874. The *upper anterior* branch is much smaller than the other, divides soon after, and even before emerging from the skull, into five twigs, which separate from each other like rays. They are the *masseteric*, the *internal* and *external deep temporal*, the *buccal* and the *pterygoid* nerves.

The *masseteric* nerve (*N. massetericus*), the most external, which generally arises the highest, pursues a transverse direction from within outward, directly before the articular surface of the temporal bone, on the outside of the pterygoideus externus muscle, where it sends filaments to the ligaments of the temporo-maxillary articulation, and to the lower part of the temporalis muscle, then descends from within outward between this muscle and the pterygoideus externus muscle, goes to the sigmoid fissure of the lower maxillary bone, and passing behind the tendon of the temporalis muscle, glides between the two layers of the masseter, in which it is almost entirely distributed.

The second twig, the *external deep temporal* nerve (*N. temporalis profundus externus*), arises farther forward and inward, often comes from the preceding or from the buccal nerve, and sometimes from a common trunk with the following. It goes outward under the pterygoideus externus on the temporalis muscles, commonly anastomoses with the following and by an intermediate filament, and goes immediately upward and inward to enter the temporalis muscle.

The third twig, the *deep internal temporal* (*N. temporalis profundus internus*), is generally larger than the preceding, and follows the same course. It is distributed also in the temporalis muscle, but also sends some anastomotic filaments to the buccal nerves. It also gives off others farther forward, which go to anastomose with the cutaneous malar and with the lachrymal nerve on the outside of, and sometimes even within, the orbit: the existence however of these last two anastomoses has been doubted, since the researches of Bock, who regards the filaments generally considered as such, as ramifications of the arteries.*

The fourth twig, the *buccinator* or *buccal* nerve (*N. buccinatorius*), is usually the largest of the five, and sometimes the trunk of the three preceding. It goes forward between the two pterygoidei muscles and through the external, sends filaments to these two muscles, particularly the external, arrives at the lower part of the temporalis muscle, then descends between this latter and the pterygoideus externus, comes on the external face of the buccinator, is distributed mostly to this muscle, passes through it to send some filaments to the membrane and to the buccal glands, anastomoses with the anterior branches of the facial nerve, and terminates in the levator and depressor anguli oris muscles.

* Bock, *loc. cit.*, p. 44.

The fifth twig, the *pterygoid* nerve (*N. pterygoideus*), is the smallest. It arises from the inner part of the superior branch, passes between the pterygoideus externus and peristaphylinus muscles and arrives at the upper part of the pterygoideus internus, to which it is entirely distributed.

§ 1875. The *posterior* and *inferior* branch is much larger than the preceding and the proper continuation of the trunk, divides soon after arising into three twigs, the *superficial temporal*, the *inferior dentar*, and the *lingual* nerve.

The *superficial temporal* nerve (*N. temporalis superficialis*) most generally arises by two, more rarely by three roots, and still more rarely by one. Of these two roots, the inferior, the smaller, comes from the inferior dentar nerve and reunites with the superior, so that the spherospinous or middle cerebral artery passes between them.

The trunk goes from within outward on the inside of the temporo-maxillary articulation between the condyle of the jaw and the lateral ligament, and here divides in five or six branches. Two or three of these branches penetrate from without inward and from behind forward in the parotid gland, and anastomose with this trunk and with some ramifications of the facial nerve. One or two of the others, which may be termed the *nerves of the external auditory passage* (*N. meatus auditorii externi inferior*, s. *superior)*, go backward, pass through the anterior wall of the osseous portion of the auditory passage, and pass between this and the cartilaginous portion. Their ramifications are distributed some in the integuments of the inner part of the external ear, and others in those of the auditory passage. We see also one of them which goes to the membrane of the tympanum, glides between its two layers, and anastomoses by one or two filaments with the cord of the tympanum.*

The last and largest branch of the superficial temporal nerve passes through the parotid gland to the external ear, and terminates in the integuments of the central part of the cranium by anastomosing with some filaments of the great occipital and the frontal nerve of the first principal branch of the fifth pair. It also communicates with some filaments of the external lachrymal twig and of the cutaneous malar nerve which go outward.

The other two nerves given off by the posterior and inferior branch of the infra-maxillary nerve at first form only a single but very short trunk.

The *inferior dentar* nerve (*N. alveolaris maxillæ inferioris, N. maxillaris inferior*), which is situated between the other two twigs of the posterior branch which is generally the largest ramification given off by the trunk of the infra-maxillary nerve, sometimes arises by two roots which embrace the internal maxillary artery. It descends from within outward and from behind forward, first between the two ptery-

* Bock, *loc. cit.*, p. 49.

goidei muscles, then between the external and the condyle of the jaw. Near its origin it gives off a small and very constant branch, the *mylo-hyoid* nerve (*N. mylo-hyoideus*), which descends from behind forward in a channel grooved in the inner face of the branch of the jaw, sends a twig to the submaxillary gland, goes towards the lower face of the mylo-hyoideus muscle, proceeds from behind forward between this muscle and the interior belly of the digastricus, gives some filaments to both of them but particularly to the mylo-hyoideus muscle, and after being reflected from below upward on the lower edge of the lower jaw, is distributed in the muscles of the chin.

The trunk of the inferior dentar nerve proceeds from behind forward in the inferior dentar canal. But it generally divides on entering into two branches, a superior which is smaller, the *dentar* nerve (*N. dentalis*), and an inferior and larger, the *mental* nerve (*R. mentalis*); these proceed at the side of each other, and communicate by numerous anastomosing filaments.

The *dentar* branch is situated below the teeth, and sends a filament to each of them and to each root of the molar teeth. All these filaments arise farther back than the teeth to which they proceed: between each two teeth it sends a filament to the gum.

The mental branch emerges through the mental foramen. It soon divides under the levator anguli oris muscle into two twigs, the *inferior labial nerves* (*N. labiales inferiores*), the internal of which is larger in a greater or less degree than the external.

The direction of the external is upward; it sends some filaments to the levator anguli oris muscle, but principally to the lower part of the orbicularis oris, the glands of the lower lip and the buccal membrane, and anastomoses with some filaments from the inferior branches of the facial nerve.

The *internal*, covered by the depressor labii inferioris muscle, goes forward and upward, sends filaments to this muscle, to the levator menti, the central part of the orbicularis oris, the skin of the chin, the glands of the lower lip, and the buccal membrane, and anastomoses with the marginal branch of the facial nerve.

The *lingual* nerve (*N. lingualis*, s. *gustatorius*), the most anterior of the three twigs of the lower and posterior branch of the infra-maxillary nerve, is between the other two in respect to size. It arises farther inward than they, and is frequently united to a considerable extent in a common trunk with the preceding. It descends with it from behind forward, usually on the inside of the internal maxillary artery, separates from the inferior dentar nerve and goes inward, receives before the palatostaphylinus and pterygostaphylinus muscles, and behind the pterygoideus externus, the cord of the tympanum, which unites with it at a very acute angle, then passes before the inferior dentar nerve, sometimes sends to the pterygoideus internus muscle a filament which is often detached above the anastomosis with the cord of the tympanum, enters between the pterygoideus internus and the ascending branch of the jaw, and passing above the submaxillary gland, gives to it as high

as the angle of the jaw several considerable filaments, which come sometimes directly from its trunk, sometimes from a small ganglion which it forms on it, and which is called the *maxillary ganglion* (*ganglion maxillare.*)

These filaments are distributed principally in the gland. Generally however one of them emerges from it, descends on the hyoglossus muscle, anastomoses with a branch of the lingual nerve, and terminates in the genio-glossus muscle.

The trunk of the lingual nerve then goes forward between the hyoglossus and mylo-hyoideus muscles, passes between the sublingual gland and the hyoglossus muscle, having before it the excretory duct of the submaxillary gland, anastomoses by several considerable filaments which come from its inner side with the hypoglossal nerve, sends some which are very minute to the buccal membrane and larger ones to the sublingual gland, and divides into seven or eight branches which proceed from behind forward and from below upward between the styloglossus and genio-hyoideus muscles. These branches separate like the sticks of a fan, and go principally to the edges and tip of the tongue, and are there distributed by minute filaments in the skin of this organ.

IX. INTERNAL MOTOR NERVE.

§ 1876. The *superior* or *internal motor* nerve, the *pathetic*, the *fourth pair*, the *internal oculo-muscular* nerve (*N. oculo-muscularis superior*, s. *minimus*, s. *musculi oculi obliqui superioris*, s. *par cerebrale quartum*, s. *N. patheticus*),* the smallest cerebral nerve, generally arises by an anterior and a posterior root, each composed of one filament about the same size. They are frequently half an inch apart, but united by cellular tissue. They arise directly behind the external half of the posterior part of the tubercula quadrigemina from the anterior and external part of the upper face of the cerebral valve, so that the anterior arises from some transverse medullary fibres which cover the valve in this place, and which unite them on the median line with those of the opposite side. This nerve seldom has three roots and still more rarely one only.

After arising, it goes downward and a little forward, first on the upper extremity of the anterior prolongations of the cerebellum, then about two lines from the anterior edge of the occipital protuberance, first on the lateral and then on the lower face of the cerebral peduncle. After proceeding much farther within the skull than any other encephalic nerve, it comes to the posterior clinoid process. There it enters into a special canal of the dura-mater, the internal wall of which is very thin and separates it from the cavernous sinus, usually anastomoses there with the first branch of the trifacial nerve by a small fila-

* Zinn, *loc. cit.*—Sœmmerring, in Demours, *loc. cit.*, vol. iv. p. 31, pl. vi., fig. 1.

ment, and is situated first below the common motor and the ophthalmic nerves. At the sphenoidal fissure it is situated above the first of these two nerves, enters into the orbit through the upper and internal part of this fissure, and its direction there is from behind forward and from without inward directly under the periosteum, attended by the frontal twig of the ophthalmic branch of the fifth pair, and enlarges much in this course. Finally, it enters the obliquus oculi superior muscle at about its centre.

X. COMMON MOTOR NERVE.

§ 1877. The *common motor* nerve, the *common motor of the eye*, the *third pair*, the *common oculo-muscular* nerve (*N. oculo-muscularis inferior*, s. *medius*, s. *oculo-motorius communis*, s. *par tertium*),* a considerable trunk generally the fourth in size, and rarely the third among the encephalic nerves, arises about two lines before the anterior edge of the annular protuberance on the inner face of the cerebral peduncle, about two lines above its lower edge, at the place where the grey cribriform plate which covers the inner face of the peduncle commences. It even arises in great part from this layer. Some smaller filaments, coming from near the internal edge of the lower face of the cerebral peduncle, usually join this root, whichis si ngle and very large.

It is however easy to follow the origin of the nerve farther upward and backward, for beyond the point where it leaves the annular protuberance it is covered anteriorly only by a very thin layer of grey substance, of which we perceive no trace posteriorly. When this substance is removed, when the annular protuberance is divided, turned from above downward, and carefully cut longitudinally on the median line, we observe that a medullary layer commences at the place where the nerve emerges, continues with its fibres, and terminates like a fan upward and a little forward, forms a fasciculus which is rounded posteriorly although straight at first, and curves from below upward.

The anterior and flat part of this layer extends to the bottom of the groove existing between the two cerebral peduncles. Its posterior parts are arranged in fasciculi, converge from before backward, and are blended at their posterior part. The anterior part is loose, but in order to see the posterior we must separate the anterior half of the annular protuberance, and turn over the two folds. The posterior part of this medullary layer then rises directly below the floor of the aqueduct of Sylvius.

The two nerves are at first attached to each other by their inner faces, so that they slightly resemble the arrangement of the optic nerves. After leaving this point, where they are detached from the encephalon, they proceed from within outward and from before back-

* Zinn, *loc. cit.*—Sœmmerring, in Demours, *loc. cit.*, vol. iv. p. 31, pl. vi. fig. 2.

ward, arrive at the external wall of the cavernous sinus, are situated within and above the first branch of the trifacial and the superior motor nerves; then changing this direction below and on the outside of these nerves they pass through the dura-mater which closes the sphenoidal fissure, and enter the orbit with the external motor and the nasal branch of the trifacial nerve.

Before passing through the dura-mater, the common motor nerve is divided into a superior and an inferior branch.

The *superior*, the smaller, goes inward and forward, passes on the optic nerve and the nasal twig of the ophthalmic branch, anastomoses with this latter, sends its twigs into the rectus oculi superior muscle, and passes through it to be distributed in the levator palpebræ superioris muscle.

The *inferior* is much larger than the preceding, and passes below and on the outside of the optic nerve, between it and the rectus oculi inferior muscle. It usually divides into three twigs, an *internal*, which is larger, which goes to the rectus internus muscle; a *middle*, which is shorter, for the rectus inferior muscle, and an *external inferior* branch, which is the longest and thinnest, and which goes to the obliquus inferior muscle, and the lenticular ganglion.

This latter gives off near its origin a short filament, which, situated on the outside of the optic nerve, goes to the posterior extremity of the lenticular ganglion, and forms its short root. This filament is always composed of several threads, arises more rarely from the lower branch, but sometimes also it comes at the same time from the external twig, from the middle, and even from the trunk of the lower branch.*

Sometimes, but very rarely, the long root of the lenticular ganglion also arises from the common motor nerve.†

XI. OPTIC NERVE.

§ 1878. The *optic* or *ocular* nerve, the *second pair* (*N. opticus*, s. *visorius*, s. *par secundum*), the largest of the encephalic nerves, arises by a broad and flat portion from the posterior part of the external face, and also from the upper face of the optic bed and the tubercula quadrigemina. Its anterior part, which is the broadest, leaves the upper face of the optic bed, from the substance of which it is easily distinguished on account of the transverse direction of its medullary fibres, to pass on its anterior and external tubercle. The posterior passes below the posterior and external tubercle, and is attached in its place to the tubercula quadrigemina, particularly the posterior, by a medullary band, which goes forward from these latter, passing below the posterior and external tubercle of the optic bed. Thence the optic nerve proceeds from behind forward and from without inward, and descends on the lower face of the cerebral peduncle, with

* Bock, *loc. cit.*, p. 12.
† Morgagni, *Ep. anat.*, xvi. § 59.—Meckel, *De quinto parc*, § 48.

which it is so closely connected that we must admit that it partly arises from this prolongation, although separated from it in almost all its extent by the pia-mater. It gradually becomes narrower, but thicker and more rounded, and unites at an obtuse angle with that of the opposite side on the median line, on the lower face of the cerebrum, below the floor of the third ventricle. The union is so intimate that the two nerves form only one medullary mass. This mass itself has the form of an elongated square, which differs in different subjects, as is indicated in Morgagni * and Wenzel,† nor has it always the same volume.‡ It receives above some medullary fibres from the floor of the third ventricle, so that we are authorized to think that the optic nerve partially arises from this point.

After this union the two optic nerves separate and go forward and outward. Hence, when we view their place of union and their anterior and posterior parts, they represent the form of an X, or of a cross. Thus, their decussation has been termed the *intercrossing* (*chiasma*). It is very rare, and perhaps never the case, that the two nerves do not unite, § or that by an arrangement, perhaps the opposite of the preceding, a small pointed protuberance comes from the anterior edge of the decussation. ||

Opinions vary in regard to the manner in which the optic nerves unite. Some assert that they are only fitted to each other,¶ others that they entirely intercross, and that of the right eye, for instance, passes to the left side of the body behind the decussation.** Finally, some think that there is only a partial decussation, an intercrossing of most of the fibres,†† that the external fibres of each nerve are situated on the same side of the body before as behind the decussation, while the internal intercross with the corresponding fibres of the opposite side, and pass to the other side of the body. ‡‡

Those who maintain the first hypothesis, assert,

1st. That on examining the decussation in the recent state, the fibres of the nerve are seen to pass through its external edge, but do

* *Ep. anat.*, xvi. § 13.

† *De penit. struct. cerebri*, p. 110.

‡ *Ibid.*

§ Vesalius, *De corp. hum. fab.* l. iv. c. iv.

|| Sœmmerring, in Nœthig, *De decussatione nervorum opticorum*, Mayence, 1780.

¶ Gallen, *De util. part.*, lib. x. c. xii.—Also a great number of his successors, mentioned in Nœthig.—Zinn, *Desc. oc. hum.*, Gottingen, 1765, p. 190.—Vic-d'Azyr, in the *Mém. de Paris*, 1781. p. 554.—Meckel, in Haller, *Grundriss*, p. 386.

** This opinion was supported before Galen, as he refutes it (*loc. cit.*); those who have defended it since, are cited by Morgagni (*Ep. anat.*) and by Sœmmerring, in Nœthig, *loc. cit.*, and *Denksder Münchner Akad.* 1808, p. 60.

†† Michælis, *Ueber die Durchkreuzung der Sehnerven*; in Gross, *Magazin zur Naturgeschichte des Menschen*, vol. ii. part i. p. 149.

‡‡ Ackermann, in the *Med. bibl.* of Blumenbach.—Wenzel, *Locus unionis nervorum opticorum*; in *De pen. str. cereb.*, cap. xi. p. 109.

not leave their side, while the middle part is absolutely homogeneous, and presents no trace of fibrous structure.*

2d. That the two optic nerves have been found entirely distinct from each other, and the sight was unimpaired.†

3d. That where the optic nerve wasted after the loss of an eye, the change in the texture was seen only in the nerve of the same side, behind the decussation,‡ and that it is very easy to distinguish in this latter the two nerves from each other, by their colour and other properties.§

The partisans of the second opinion state,

1st. The normal appearance.‖

2d. Those cases where the origin of one optic nerve, or the part of the two nerves behind the decussation has been found unusually large or small, and the nerve on the opposite side presented the same character before the decussation,¶ while the sight was unaffected.

3d. The cases in which the disease of the nerve before the decussation extended behind it only to the nervous cord of the opposite side, and affected even the corresponding cerebral portions of this side.**

4th. The analogous cases where the origin of one of the two nerves was affected, and the functions of the eye of the opposite side were deranged.†† Sometimes only this origin was diseased, and not the portion of the nerve on the other side of the decussation.‡‡

5th. The analogy with several animals, particularly with most fishes, the nerves of which evidently intercross and enter each other.

The third hypothesis is supported,

1st. By the anatomical examination of the parts in the normal state.§§

* Vicq-d'Azyr, *loc. cit.*—Wenzel, p. 111, 115. This anatomist admits that a small portion of the inner part proceeds to the opposite side before they unite; but as he expressly remarks that he has been unable to discover any fibre in this internal part, the preceding sentence does not favour the decussation, since the direction he allows to the fibres is only that of the whole nerve.—Caldani (*Mem. delle soc. ital.*, vol. xii. part ii. p. 28), has found the optic nerves united behind the decussation by a transverse medullary band.

† Vesalius, *loc. cit.*—Nicolas de Janua, in Caldani, *Opusc. anat.*, Padua, 1803, p. 40.

‡ Vesalius, *loc. cit.*—Cesalpino, in Riolan, *Anthopogr.*, l. iv.—Cheselden, in the *Phil. Trans.*—Santorini, *Obs. anat.*, c. iii. p. 63, 64.—Meckel, in Haller, *Grundriss*, p. 386.—Caldani, *Opusc. anat.*, p. 33 and 35: two cases.—Id., in *Mem. delle soc. ital.*, vol. xii. plate ii. p. 27.—Burns, *Anatomy of the head and neck*, Edinburgh, 1811, p. 359.

§ Santorini, *loc. cit.*

‖ Petit, in the *Mém. de Paris*, 1736, p. 7.—Sœmmerring, *loc. cit.*

¶ Sœmmerring, *loc. cit.* Several cases.

** Michælis, *loc. cit.*, p. 145.—Caldani, *loc. cit.* p. 35.—Wenzel.

†† Valsalva, in Morgagni, *Ep. anat.*, xiii. p. 115. obs. iii.

‡‡ Wenzel, *loc. cit.*, p. 125.

§§ Caldani, *Opusc. anat.*, p. 37, tab. ii. fig. 4. The simple maceration in water, immersion in sulphuric acid and vinegar, gave no result; but this is not the case with nitric acid after the neurilemma was removed. Caldani has observed, eight times in this manner, that the external nervous fibres went directly to the ... of the same side, and the internal to that of the opposite side, that consequently these latter intercrossed, and that even the fasciculi visibly divided into several

2d. By those pathological cases where one eye being destroyed and its nerve affected, the external fibres of the diseased nerve and of the healthy nerve remained each on their side before and behind the decussation, while the internal fibres of the healthy eye passed through it to go to the opposite side, where they formed the internal fibres of the nerve of this side, and the internal fibres of the diseased nerve also passed to the healthy side, although less evidently, at least in some cases.*

3d. By the cases, where after the disease of an eye and of its optic nerve, the decussation and the nerve of the same side behind it, were wasted.†

4th. By the cases of the loss of an eye with the affection of only one optic nerve before the decussation and of the opposite nerve, or of both, behind this point.‡ This fact really seems to favour the hypothesis of a partial decussation, since different physiologists think it cannot be explained otherwise, and more so, because in many cases where the two nerves were wasted behind the decussation, that of the healthy eye was found unusually large.§

When all these pathological facts are duly considered, we must admit that they do not prove positively either of the three opinions, inasmuch as the dissection of the healthy parts has not demonstrated the fact of the decussation. In fact, they may be explained satisfactorily by saying that the substance of the two nerves is so blended in the decussation, that these nerves do not partially or wholly cross, and still less are they placed one against the other, but they properly arise from this common substance formed by the union of the two *optic bands* (*tractus optici*), which opinion differs much from that of a partial decussation. The differences of the pathological phenomena authorize the adoption of this hypothesis, as this alone explains them very well. We may then consider as accidental, that where the optic nerve is diseased to the decussation, the alteration is observed on the other side of this union, on the cord of the same side, on that of the opposite side, or on both at once. This intimate union of the two portions of the optic nerves between their origin and decussation, is rendered very probable by what we have remarked, and which had been seen before us by Morgagni,|| Michælis,¶ Bichat,** and Wenzel,†† that when the optic nerve had wasted and had been grey

branches. Wenzel has once found in a subject whose sight was not affected, some grey substance in the centre of the decussation; the internal fibres of the two nerves evidently passed through this substance to intercross (*loc. cit.*, p. 118).

* Wenzel, 113, 217.

† Walter, *Ueber die Einsaugung und die Durchkreuzung der Sehnerven*, Berlin, 1794, p. 97.

‡ Ackermann, *loc. cit.*—This has been seen in most cases.

§ Morgagni, *Epist. anat.*, xviii. 40.—Michælis, *loc. cit.*, p. 145.—Wenzel, p. 125.

|| *Epist. anat.*, xviii. 40.

¶ *Loc. cit.* p. 146.

** *Anat. descript.*, vol. iii. p. 153.

†† *Loc. cit.* p. 112.

for a long time either before or behind the decussation, the decussation itself and the portion of the nerve before or behind it, was not in the least abnormal, and when the contrary occurred, the portion separated by the decussation from that first affected by the disease, was always altered much less than this latter. This phenomenon certainly indicates a great difference and a marked distinction between the posterior part of the nerve, including the decussation and the anterior portion, and the more, as when the portion situated before or behind the decussation is diseased, it usually presents the same kind of alteration in all its extent.

The differences between the pathological phenomena, mentioned by us above, depend perhaps on primitive differences of structure. This conjecture seems much more probable, as the structure of the nervous system, notwithstanding its great regularity, nevertheless frequently presents, when attentively considered, very great anomalies. It is then possible, that as in other organs situated on the median line, the union is sometimes more, sometimes less intimate, sometimes there is merely a juxta-position, and that there are a series of successive states, the first link of which is the case described by Sœmmerring, in Nœthig, and the last, that mentioned by Vesalius, although Haller rejects this hypothesis.*

Finally, the texture of the optic nerve before or behind the decussation, according as the origin of the nerve or the eye are primitively affected, proves nothing in favour of either of these three opinions, since in some cases where the sense of vision was lost in both eyes at the same time, one of the nerves was much thinner than the other behind the decussation.†

Finally, according to our own observations, this partial decussation is very probable; some at least of the differences in the pathological phenomenon may then be easily explained, since, when the inner part of the optic nerve is affected, that of the opposite side, and when the outer part is diseased, that portion of the same nerve behind the decussation presents marks of disease.

§ 1879. The two optic nerves separate on leaving the decussation, and pass through the optic foramina into the cavity of the orbits. Here they are situated between the recti muscles of the eye, curve and become convex outward. When near the eye they contract very much, pass through the sclerotica and also the choroid membrane, and terminate in the organ, expanding in the retina.

They are first covered with neurilemma before the decussation. This membrane has there more firmness than in the other nerves, and penetrates within them, forming distinct sheaths. The optic nerves differ from all others, not only because they reunite, but also because they are intimately enveloped in all their course by a fibrous sheath, which is continuous posteriorly with the periosteum of the orbit and dura-mater, anteriorly with the sclerotica.

* *El. phys.* book xvi. vol. v. p. 752.
† Wenzel, p. 115, obs. ii.

XII. OLFACTORY NERVE.

§ 1880. The *olfactory* nerve, the *first pair*, the *ethmoidal* nerve (*N. olfactorius*, s. *par primum*, the *caruncula* of the ancients, who considered the optic nerves as the first cerebral pair), is situated on the lower face of the hemispheres of the cerebrum, in a groove which is there seen, but a few lines from their inner edge. It goes a little obliquely from without inward, so that the cords of the two sides are separated anteriorly only by the *crista galli* process. In this course it advances on the body of the sphenoid bone and the cribriform plate of the ethmoid bone, covered by the pia-mater, which extends like a bridge from one edge of the groove in which it is situated, to the other. This groove, however, is much deeper than the thickness of the nerve, and like all the other anfractuosities of the cerebrum, the pia-mater exactly covers its surface in all parts.

The olfactory nerve arises by three medullary bands or roots, from the posterior and inner part of the anterior lobe of the cerebrum, where this latter unites to the posterior lobe. The external band is the narrowest and strongest. Convex posteriorly, concave anteriorly, its direction is from behind forward, from without inward, and from above downward in the fissure of Sylvius, at the union of the anterior lobe with the posterior, proceeds at first almost transversely, then descends nearly perpendicularly, and reunites with the internal root some distance from the posterior extremity of the lower face of the anterior lobe.

The middle root, the shortest, and which it is generally more correct to consider only as the internal portion of the external root, arises from the centre of the anterior perforated plate, or even directly from this plate by some fibres, of which the internal are concave inward, and the external are straight. After proceeding from one to two lines, it unites to the external root and gives rise to a common trunk a line and a half large and very broad, the direction of which is oblique from behind forward and from without inward.

The internal root is from one to four lines long. It comes from the internal posterior extremity of the lower face of the anterior lobe, proceeds obliquely from above downward, from behind forward, and from within outward, and anastomoses with the common trunk of the others.

All these roots are so imbedded in the grey substance that we perceive only their internal faces, and we cannot demonstrate them in every part without separating them by art.

Very probably all the grey substance in which they are imbedded should be regarded as a portion of the cerebrum, which is connected with the origin of the olfactory nerve. This portion is oblong. It is continuous outward with the union of the anterior and posterior lobes, backward with the anterior perforated or cribriform plate, forward at its outside and inside with two circumvolutions which bound the fis-

sure of the olfactory nerve. It is loose at its centre and forms the posterior wall of this fissure within which it projects.

The nerve enlarges much from behind forward, so that its anterior extremity is two or three times thicker than its origin.

It is prismatic, the base looks downward, the two lateral faces are turned inward and outward, and the upper angle is the most acute.

In its whole extent it is very evidently formed of grey and of white substance disposed in longitudinal fibres, which proceed at the side of each other and interlace together. Its anterior and enlarged extremity, called the *bulb of the olfactory* nerve (*bulbus n. olfactorii*), is that part where, proportionally speaking, we find the most of grey substance.

In all the rest of the course of the nerve this substance is particularly abundant in the inner side. On the outside it is seen near the lower face.

The lower face of the bulb is the only part of the olfactory nerve whence filaments arise. These filaments, each of which is surrounded by a small prolongation of the dura-mater, pass through the openings of the cribriform plate of the ethmoid bone, thus enter in the nasal fossa, and are mostly distributed in the mucous membrane which lines the septum and the turbinated bones. They are distingushed into *nternal*, *middle*, and *external*. We shall mention the manner in which hey are distributed when describing the organ of smell. *

CHAPTER III.

GANGLIONNARY NERVE.

§ 1881. The *ganglionnary* nerve, the *nervous system of the ganglions*, the *great sympathetic* nerve, the *intercostal*, the *trisplanchnic* erve (*N. gangliosus*, s. *N. sympatheticus magnus*, s. *intercostalis aximus*, s. *vertebralis*, Lieutaud, s. *trisplanchnicus*, s. *systema vitæ ntomaticæ vegetativæ*, Bichat, Gall),† differs so remarkably from all

* The olfactory nerve has been considered as the conductor of the sensations oduced by odours. Magendie, however, refers this function to the fifth pair, which nds so many different twigs into the nose. He rests his opinion on the fact, that e destruction of the olfactory nerves, and even of the anterior cerebral nerves, is ot attended with the loss of smell, which, however, is always the case when the o nerves of the fifth pair are divided (*Le nerf olfactif est-il l'organe de l'odorat?* the *Journ. de phys. expérim.*, vol. iv. p. 69). If this opinion be confirmed, the hmoid nerve does not differ in this respect from the hypoglossal. F. T.

† Consult. 1st. On this nerve in general: C. Bergen, *De nervo intercostali*, fort, 1731.—A. F. Walter, *Programma quo paris intercostalis et vagi corporis mani nervorum et ab utroque latere ejus obviorum anatomen exhibet*, Leipsic, 1733, 35. J. F. Huber, *De nervo intercostali, de nervo octavi et noni paris deque accesio*, Cassel, 1744.—C. C. Schmidel, *De nervo intercostali*, Erlangen, 1751.—M. rardi, *De nervo intercostali*, Florence, 1791.—A. Portal, *Description du nerf interstal dans l'homme*; in the *Mém. de l'Institut*, vol. iv. Paris, an. xi. p. 151, 209,

the other nerves and is so opposed to the rest of the nervous system in several respects that it would be more proper not to place it in the same class with the encephalon, the spinal marrow and their nerves, but to consider it as a different but subordinate system.

§ 1882. The system is formed of numerous ganglions, varying in number and size not only in both sides of the same subject but also in different individuals, and of nervous twigs, some of which unite these ganglions in several different ways, while others are given off to enter the organs. It exists uninterruptedly on the two sides and the anterior face of the vertebral column, along the neck, chest, and abdomen, so that its two halves frequently anastomose on the median line; it extends from the base of the skull to the lower extremity of the trunk, and is distributed in the organs of vegetative life.

The ganglions of this nervous system divide in respect to their situation and mode of distribution into two classes which comprise, the first the *internal* or *central ganglions*, the second the *limiting ganglions*.

The *central* ganglions are principally situated in the abdomen, around and above the trunks of the large vessels near the principal organs, those which appear most independent in their functions. Several adjacent ganglions are united to each other by larger or shorter filaments, and thus form a plexus whence arise some nerves which go to the organs, also some filaments which anastomose with other similar plexuses. The *limiting* ganglions are situated on the two sides of the vertebral column in succession. They are fewer in the neck than the chest and abdomen, and are generally found in the two latter sections of the trunk between each two vertebræ. They are situated behind the serous membranes of the thoracic and abdominal cavities, and anastomose by some longitudinal cords with each other and with the central ganglions by some oblong or transverse fibres, and with most of the nerves of the centre of the nervous system,

in the *Anat. med.*, vol. iv.—Bock, *Ueber das Gangliensystem*; in *Abhandlung uber das fünfte Nervenpaar*, Meissen, 1817.—E. H, Weber, *Anatomia comparata nervi sympathetici*, Leipsic, 1817.—J. F. Lobstein, *De nervi sympathetici humani fabrica, usu et morbis*, Paris, 1823.—2d. On its origin: D. Iwanhoff, *De origine nervorum intercostalium*, Strasburg, 1780.—J. Munniks, *Observatio qua ad illustrandam artem medicam, ostenditur origo nervi intercostalis, ejusque commercium cum aliis nervis, ab ejus origine usque ad exitum e calvaria, cum autopsia, tum observatis medicis confirmata*; in his *Observ. var.*, Groningen, 1805. no, ii.—3d. On some of its parts: C. T. Ludwig, *De plexibus nervorum abdominalium atque nervo intercostali duplici observationes nonnullæ*, Leipsic, 1772.—H. A. Wrisberg, *Obs. anat. de nervis viscerum abdominalium partic. I; de ganglio plexuque semilunari*, Gottingen, 1780 G. Walter, *Tabulæ nervorum thoracis et abdominis*, Berlin, 1783.—H. A. Wrisberg, *De nervis visc. abdom.*, part ii., *de nervis systematis cœliaci. Sectio I; de nervis gastricis, quæ est observationum de ganglio plexuque semilunari continuatio*; in the *Sylloge comment.*, 1800, p. 551, 570.—H. A. Wrisberg, *Obs. anat. neurolog. de nervis viscer. abdom.*, part iii., *de nervis systematis cœliaci II; de nervis hepaticis et splenicis, quæ est observationum de ganglio plexuque semilunari continuatio II*, Gottingen, 1808.—4th. On its functions. Broussais, *Réflexions sur les fonctions du système nerveux en general, sur celles du grand sympathique en particulier, et sur quelques autres points de physiologie*; in the *Journ. univ. des sc. méd.*, vol. xii.

particularly with the anterior and posterior branches of all the spinal nerves, by intermediate filaments.

Such is the most general view of the ganglionnary nerve which can be presented. The chain of the limiting ganglions and of the nervous cords which unite them have been generally and until lately considered as its trunk and its upper extremity as it origin, admitting that prolongations proceed outward from these two points to the nervous system of animal life, inward to the thoracic and abdominal viscera. But now it is admitted to be more proper to describe first its most internal part, and to conclude with the history of the ganglions which connect it with the nervous system of animal life, and the filaments which establish the communication.

I. CENTRAL PORTION.

§ 1883. The centre of the ganglionnary nerve is formed of several ganglionnary plexuses situated in the cavity of the abdomen, and of the nerves which proceed from them to the organs, and the limiting ganglions. These plexuses considered from above downward are as follow:

§ 1884. The *solar plexus*, the *semilunar ganglion*, the *suprarenal ganglion* and *median plexus*, (*P. solaris*, Willis, s. *G.*, s. *P. semi-lunaris*, *abdominalis*, *transversus*, *communis*, *cerebrum abdominale*) deserves to be first studied, since from its size, the constancy of its ganglions whence all the abdominal plexuses emanate, and its direct connection with several of the limiting ganglions, it is the real centre of the nerve.

It is situated before the abdominal aorta, behind the peritoneum, between the two renal capsules, and it surrounds the trunk of the cœliac artery.

The ganglions which unite to form it vary in number and size. We however always find at least two ganglions, a right and a left, which when many exist are always the largest. They are almost semicircular, generally more than an inch long, about half an inch broad in several parts particularly in the centre, and several lines thick from before backward. Their convex edge is turned outward, their concave edge inward.

The right is generally much larger than the left, broader in proportion to its length, angular and rhomboidal. It is situated between the ascending vena-cava and the right pillar of the diaphragm and the right renal artery and the upper extremity of the right renal capsule.

The left, smaller, is proportionally larger and more semicircular; it is situated between the left pillar of the diaphragm, the pancreas, the splenic artery, and the left renal capsule.

Both are united by numerous nervous filaments which proceed transversely from the internal edge and the two extremities of one to the

corresponding points of the other. All or most of these filaments ramify more or less in their course and frequently anastomose.

We usually observe between the two principal ganglions, particularly between their lower extremities in the space between the cœliac and superior mesenteric arteries, two or three which are smaller: these anastomose with each other and with the two large ones by intermediate filaments, and apparently belong sometimes to the right and sometimes to the left ganglion.

Sometimes the principal ganglions instead of being thicker and broader at their centre as is usual, are very narrow there, while they enlarge at their extremities. This arrangement is the first step towards a rare anomaly, where they divide from above downward in a variable number of enlargements which communicate by nervous filaments. The middle enlargements thus formed are generally the largest; but sometimes although more rarely they are smaller than the superior and inferior, which renders the arrangement of the nerve still more abnormal.

The ganglions in the first case are nearer each other than in this latter; in the latter case they are sometimes united in several nervous filaments interwoven like a plexus. Sometimes from three to eleven small subordinate ganglions form on the outside above and below one or both of the principal ganglions; from these arise filaments which go to the adjacent plexuses, and also those which assist to form the great splanchnic nerve. The principal ganglion of the same side is more or less enlarged, so that this formation leads still more directly to that where it is entirely divided into a considerable number of smaller ganglions which are nearly equal in size.

Of all these forms those where the central portion is most concentrated is evidently superior to the others: they present a very remarkable repetition of the development of the centre of the nervous system of animal life both in the fœtus and in the whole series of animals.

The whole solar plexus is considerably large and extends longitudinally from the upper edge of the cœliac artery to below the renal arteries, and it is from one to two inches broad.

It generally divides like the cœliac artery into three principal parts.

Some nervous filaments proceed directly from its middle and upper part; they unite to other filaments of the left pneumo-gastric nerve, give rise to the *superior coronary plexus of the stomach*, *stomo-gastrique*, Ch. (*P. coronarius*, s. *ventriculi superior* s. *minor*), which accompanies the superior coronary artery along the small curve of the stomach, extends to the left orifice of this viscus and anastomoses particularly on the posterior face of the stomach with the inferior coronary and the left hepatic plexus, with which it communicates by twigs.

The second and largest of these plexuses is termed the *hepatic plexus* (*P. hepaticus*). It descends from left to right. One portion attends the right inferior coronary artery along the great curve of the stomach, where it is distributed and is termed the *inferior coronary plexus* (*P. coronarius stomachicus inferior*): the other is larger and

joins the hepatic vesssels with which it goes to the liver. It first attends the hepatic artery, but near the sinus of the vena-porta it divides into a *right* and a *left hepatic plexus.* The first is larger than the other, and is formed of from six to eight filaments. It enters into the right lobe of the liver and the left goes to its left lobe. Both anastomose with some filaments of the right pneumo-gastric nerve and also form at intervals small prominences in the substance of the liver. Before entering this gland they send some filaments to the pylorus, and also to the duodenal and pancreatic arteries.

Independent of these plexuses a smaller one is sometimes detached om the right semilunar ganglion, the filaments of which proceed rom behind forward and from below upward in the small lobe of the ver.

The *splenic plexus* (*P. splenicus*) arises from the right lower part of ie solar plexus and the left semilunar ganglion, the branches of which ccompanying those of the splenic artery which they surround pass 1 the pancreas, send some filaments to this gland, and also to the rge cul-de-sac of the stomach, where they form the *small inferior exus of the stomach* (*P. ventriculi inferior et minor*), and then enter to the substance of the spleen with the branches of the splenic arry.

Some branches arise from the lower part of the semilunar ganglions the solar, the hepatic and splenic plexuses, and unite to form the *su-rior mesenteric plexus* (*P. mesentericus superior*). This plexus acmpanies the trunk and branches of the superior mesenteric artery: filaments are distributed principally to the small and large intestine, d some enter the pancreas.

The upper part of the semilunar ganglions send off on each side r or five considerable branches which are enlarged by some filaments m the superior mesenteric plexus, descend towards the renal arte-, and interlacing by five or six subordinate ganglions form the *renal us* (*P. renalis*) on each side, which give numerous ramifications to renal capsules and to the kidneys.

This plexus communicates upward and outward with the inferior racic and the superior lumbar ganglions by twigs, of which the er unite in larger branches which go separately to the limiting glions and the nervous cords by which these latter are united.

he same plexus is continuous below with the *spermatic plexus* (*P. maticus*), which descends along the spermatic vessels, anastomoses h the superior and inferior mesenteric plexuses, gives some filats to the ureter, and extends in man to the testicle. in the female he ovary.

Some branches arise below from the superior mesenteric plexus, ends before the abdominal aorta, and enter the *inferior mesenteric, left colic plexus* (*P. mesentericus*, s. *mesaraicus inferior*, s. *medius*, ussens). This latter, which is smaller than the upper, embraces inferior mesenteric artery. It contains but a few small ganglions r this artery.

On entering the pelvis it divides into two pairs, one the *proper inferior mesenteric plexus* attends the branches and twigs of the inferior mesenteric artery, and anastomoses with the lumbar ganglion and sometimes also with the anterior branches of some lumbar nerves.

The other has a direction outward and downward, is termed the *hypogastric plexus* (*P. hypogastricus*, s. *mesentericus inferior*, s. *tertius*, s. *posterior*), anastomoses with the lumbar and sacral portions of the terminal cord of the ganglionnary nerve like the sacral nerves, and attending the hypogastric vessels is distributed to the rectum and the bladder, and in the male to the prostrate gland and vesiculæ seminales, in the female to the uterus and vagina. It also emerges from the pelvis with the external branches of the hypogastric artery.

II. LIMITING CORD AND ITS BRANCHES.

§ 1885. We have already mentioned generally the arrangement of the limiting cord which is situated on the two sides of the vertebral column and the skull. We describe it from above downward, and commence by the superior cervical ganglion which exists constantly.

A. SUPERIOR CERVICAL GANGLION.

§ 1886. The *superior cervical*, the *olivary* or *fusiform ganglion* (*G. cervicale supremum*, s. *olivare*, s. *fusiforme*), one of the largest of those of the ganglionnary nerve, is situated above and behind the angle of the lower jaw, behind the internal carotid artery before the transverse processes of the second and third cervical vertebræ and the rectus capitis major anticus muscle, on the inside of the pneumo-gastric and hypoglossal nerves. It is surrounded by a cellular sheath which envelops also the trunk of the pneumo-gastric nerve.

Its form and size vary much. It is almost always oblong, thinner below than above, terminates however also in a point at its upper and fusiform extremity. Sometimes it tends to divide into several ganglions situated successively from above downward. The first degree of this anomaly is a contraction in its centre. Next comes the formation of an upper or lower appendage; we then observe contractions in two or three points.* Its does not constantly extend entirely to the carotid canal. Below it usually descends to the third, sometimes however to the sixth cervical vertebra. Generally it is an inch and half long and its greatest breadth is three lines: its length however varies from some lines to four inches, but its breadth and thickness are always inversely as its length.

It sends off numerous branches upward, outward, inward, forward, and downward.

* Lobstein has figured (tab. v, fig. 3) a superior cervical ganglion which he has found double.

I. UPPER BRANCHES.

1. The superior branch is sometimes, although very rarely, double, leaves the upper extremity of the ganglion, enters into the carotid canal, and establishes a communication between the ganglionnary nerve and the portion of the nervous system of animal life contained in the skull. It is situated behind the internal carotid artery, towards the lower curve of which it usually divides into two nearly equal branches, which separate at an acute angle, and ascend in the canal before the carotid artery, one being more external than the other.

Opinions vary both in regard to their mode of anastomosis and the number of the portions of the nervous system contained within the skull, with which the ganglionnary nerve communicates by these filaments; these differences in opinion depend partly on the difficulty of dissecting such delicate parts, partly on the varieties in their arrangement.

The most ancient opinion was that the ganglionnary nerve anastomosed only with the fifth pair.*

At a later period it was asserted to anastomose only with the external motor nerve.†

Then it was admitted to be connected with both.‡

Anatomists vary also as to the point where the ganglionnary nerve communicates with the two encephalic nerves; the differences in opinions are but slight and trivial in regard to the external motor nerve; but they are great in regard to the fifth pair, for it anastomoses according to some with the trunk of this nerve,§ according to others with one‖ or more¶ or even with all of its branches. Some think they communicate directly,** others indirectly and by ganglions:†† the descriptions also of the anastomosis with the sixth pair vary in this last respect.

§ 1887. The ganglionnary nerve always anastomoses with the sixth pair in the carotid canal by a considerable branch coming from the superior cervical ganglion, which ascends along the internal carotid artery, first on the outside and then on its anterior face.

* Galen, *De nervorum origine*; in *Op. omn.*, Venice, vol. ii. p. 54.—The Arabians and the first Italian anatomists have adopted his opinion. Rau and Valsalva assert that they have sometimes observed this arrangement since. (Morgagni, *Ep. an.*, xvi. p. 330).

† Eustachius, tab. xviii. fig. 2.—Morgagni, *Adv. anat.*, vol. vi. p. 30.—Santorini, *Obs. anat.*, c. iii. p. 67.

‡ Meckel.

§ Schmidel, Munniks, Bock.

‖ Most authors.

¶ Laumonier.

** Most authors who have written on this subject and on neurology in general.

†† Petit, *loc. cit.*—Schmidel, *loc. cit.*—Laumonier, in Bacher, *Journ. de méd.*, vol. xciii. March, 1793, p. 259.—Munniks, *Obs. var.*—Cloquet, *Tr. d'anat.*, vol. ii. p. 686.

This branch generally unites to the external motor nerve by a single twig which meets it, and is detached at an acute angle from the external and inferior part of the sixth pair during its passage through the cavernous sinus.

This twig is not unfrequently double, and sometimes the recurrent filament of the external motor nerve bifurcates soon after arising.

Sometimes also the anastomosing branch of the ganglionnary nerve within the sixth pair is double, in which case one proceeds on the outside the other on the inside of the internal carotid artery.

We frequently, and even perhaps always, find at the upper part of the carotid canal or in the cavernous sinus, instead of a direct anastomosis, a ganglion situated on the outside of the internal carotid artery called the *cavernous ganglion* (*G. cavernosum*). Three or more filaments proceed from the summit of this ganglion to the nerve of the sixth pair.*

The anastomosis with the trifacial nerve is always by a filament which goes to the recurrent twig of the second branch of the fifth pair or the vidian nerve. This filament is distributed partly in the carotid artery, partly also emerges from the carotid canal, passes through the dura-mater, and enters the pterygoid canal where it unites with the recurrent twig.

Thus the branch from the upper extremity of the upper cervical ganglion usually divides into these two filaments, one of which goes to the external motor, the other to the trifacial nerve.

This bifurcation generally takes place within the carotid canal, seldom below and never above it.

Sometimes but rarely also the upper extremity of the superior cervical ganglion gives origin to two superior branches, which go one to the external motor, the other to the vidian nerve.

When this arrangement exists the two anastomotic filaments and the vidian nerve communicate with the external motor nerve. Sometimes also this triple anastomosis does not exist.

An analogous case is where either the anastomosing filament which goes to the external motor nerve or that which proceeds to the trifacial or both divide into several filaments, all of which unite in a common trunk to go to the superior cervical ganglion.

§ 1888. This is the only anastomosis admitted by most authors between the ganglionnary and the trifacial nerves. In fact it is often the only one which can be demonstrated. But the great sympathetic nerve also unites by its upper extremity in another manner, at least sometimes, with the trifacial nerve.

Many anatomists, and Portal among others, positively reject this other anastomosis; but many observations favour its existence.

In fact, according to Schmidel and Munniks, several filaments come from the ganglionnary plexus of the fifth pair, and go to the carotid

* Laumonier, *loc. cit.*—Munniks, *loc. cit.*

canal, where they unite with other filaments of the external motor nerve and form a ganglion.

Others, however, whose opinions are like the preceding, assert that, beside those filaments mentioned, or even if they do not exist, we find a smaller twig coming from the first branch of the fifth pair; and this unites sooner or later either with the anastomosing filament of the sixth pair, as Petit,* Schmidel,† and Coopmanns‡ assert, or with the cavernous ganglion.§

Laumonier, on the contrary, has found coming from the cavernous ganglion, the two filaments which anastomose with the sixth pair and he vidian nerve, and also a third which went to the second branch of he fifth pair, and a fourth to the fourth branch of this same pair.‖ Bock ¶ asserts that ten filaments go to the anterior extremity of the trunk of the fifth pair, particularly towards the portion which corresponds to the first branch.

All these assertions, however, agree in this, that beside the filaent which anastomoses with the vidian nerve, one or more anastomoses exist nearer the origin of the fifth pair with one or several of its iree principal branches, or with its trunk: these anastomoses take lace by a ganglion, and from this arises the filament of communicaon with the superior cervical ganglion.**

We also sometimes find a more indirect anastomosis between the pper extremity of the ganglionnary nerve and the third pair of cereal nerves, the latter anastomosing with the sixth and fifth in the ace where they give filaments, which communicate with the great mpathetic nerve.††

According to Fontana‡‡ and Ribes,§§ whose correctness we have rtially attested, the ganglionnary nerve penetrates still farther upard and forward, for it sends some filaments from the carotid canal to e pituitary gland,‖‖ or to the infundibulum,¶¶ and also a fasciculus iich accompanies the ophthalmic artery, forms a plexus around the ferent branches of this vessel, not excepting the central artery of the tina, and anastamoses by a filament with the lenticular ganglion,

Loc. cit., p. 4.
Loc. cit., p. 16, 21.
Loc. cit., p. 219.
Cloquet, *loc. cit.*, p. 687.
Loc. cit., p. 259.
Vom fünften Nerven, p. 3.
* Lobstein does not admit all these anastomoses; he has seen some transparent gelatinous filaments which united the ramifications of the great sympathetic ve with the common motor and other nerves; but by examining them with the roscope, he has not found in them the characters of nervous organs. He regards n as cellular tissue extended in filaments. F. T.
Munniks, *loc. cit.*, p. 25.
In Girardi, *loc. cit.*, p. 25. As Carus (*Anatomie und Physiologie des Nervenems*, p. 185) has also observed in several reptiles.
Ribes, *Rech. anat. et phys. sur quelques parties de l'œil*; in the *Mém. de la soc. d'émul.*, vol. vii. p. 97.
Fontana, *loc. cit.*, p. 56, 57.
‖ Cloquet, *loc. cit.*

consequently with the first principal branch of the fifth, and with the third pair.* And likewise as there exists also between the lenticular ganglion, the cavernous sinus, and all the ganglionnary system, a constant relation,† similar to that between the two ganglions, we consider this small filament with the ciliary nerves which come from it, as making part of the great sympathetic nerve, which supposition seems to us very probable.

II. EXTERNAL BRANCHES.

The external branches are from one to four in number, pass above the rectus capitis major anticus muscle, to go and meet the first and second cervical nerve. When there is only one it is larger, and soon divides into as many branches as generally exist, comes sometimes from the upper, and sometimes from the centre of the superior cervical ganglion. The upper two arise from the upper extremity of this same ganglion, directly at the side of each other, and anastomose with the anastomotic plexus of the first and second cervical nerves. The third communicates with that of the third and fourth cervical pairs. The fourth which arises more frequently from the twig of communication between the first and second cervical ganglions, anastomoses on one side by several filaments with the anastomotic plexus of the third and fourth cervical nerves, and is distributed in the rectus capitis major anticus and the scalenus anticus muscle.

III. INTERNAL BRANCHES.

The internal branches are much smaller and less constant in respect to number, and are distributed to the longus colli, the rectus capitis major anticus muscle, the pharynx and the larynx.

IV. ANTERIOR BRANCHES.

The anterior branches are the largest and most numerous. They are distinguished by their reddish tint and their softness, and hence are termed *soft* nerves (*N. molles*). The superior are shorter than the others, proceed from below upward, and anastomose with the hypoglossal, the pneumo-gastric, and the facial nerves, just after they emerge from the skull. The middle and inferior are larger, go forward and downward, envelop the primitive carotid arteries to their origin, anastomose in this course with some branches of the pneumo-gastric nerve, and surround also, together with the facial and pneumo-gastric nerves, the branches of the external and internal carotid arteries, to the carotid canal. The latter not unfrequently come from a distinct small ganglion.

* Ribes.—Cloquet.—Bock.
† Ribes.—Cloquet.—Bock.

The largest anterior branch is the *superior* or *superficial cardiac* nerve (*N. cardiacus superior*, s. *superficialis*), which arises by from four to six filaments from the internal anterior part of the cervical ganglion, sometimes also partially or wholly from the upper extremity of the cord which joins this ganglion to the following. The minute nerve formed by the union of these filaments, descends on the outside of the primitive carotid artery, covered by the cord of communication of the great sympathetic nerve, gives off at about its centre some filaments which surround the inferior thyroid artery, anastomoses with one or two twigs of the pneumo-gastric nerve, communicates also with the descending branch of the hypoglossal nerve, gives ramifications to the pharynx, the esophagus, the sterno-hyoideus and sterno-thyroideus muscles, and usually terminates partly by anastomosing with some ramuscules of the recurrent branch of the pneumo-gastric nerve, and partly sends retrograde filaments to the thyroid gland. It more rarely descends to the arch of the aorta, where it unites to the middle cardiac nerve; but it never extends to the heart, so that it does not deserve the term applied to it.

That of the left side commonly extends farther than that of the right.

V. INFERIOR BRANCH.

The inferior branch establishes the communication between the su-erior and the middle, or the inferior cervical ganglion, and is generally onsidered as the continuation of the trunk. It varies in size and firm-ess. It is generally thinnest in its centre, and is always larger than the perior cardiac nerve which is situated before and on the inside of it. constantly arises from the lower extremity of the superior cervical anglion, with which it is less directly continuous, the larger it is and e smaller the ganglion. Its length depends on that of the superior anglion, and on the presence or absence of the middle one. It ways exists. It is situated before the rectus capitis major anticus id the longus colli muscles, near the inner edge of this latter, first hind the internal carotid artery, then behind the primitive carotid, tween the internal jugular vein and the pneumo-gastric nerve.

It is most generally single. Very rarely it is divided at its lower rt into two twigs, which embrace the inferior thyroid artery, and iich usually enter, one the middle cervical ganglion, the other the ferior cervical ganglion.

This branch anastomoses by some external filaments with the ac-ssory and several cervical nerves, more frequently with the superior in the inferior, sometimes even with the eighth. These differences l those in the length of the cord, depend on those in the size of the perior cervical ganglion, and also on the presence or absence of the ldle ganglion. The anastomosing branches generally unite in ie larger branches before coming to the trunk of the ganglionnary ve.

From this branch arise some filaments which contribute to form the superficial cardiac nerves. It gives some also which unite to others coming from the superior cervical ganglion, sometimes arise only from the superficial cardiac nerves, and go almost transversely inward, and are distributed, the superior particularly, in the constrictor muscles of the pharynx, the inferior in the thyroid gland, the muscles, and the mucous membrane of the larynx. These filaments frequently anastomose with each other or with some ramifications of the pneumo-gastric and glosso-pharyngeal nerve.

B. MIDDLE CERVICAL GANGLION.

§ 1889. The *middle cervical* or *thyroid* ganglion (*G. cervicale medium.* s. *thyroideum*) is situated at the origin of the inferior thyroid artery, between the fifth and sixth, or between the sixth and seventh cervical vertebræ, directly before the longus colli muscle, behind the primitive carotid artery and the pneumo-gastric nerve. It is not so constant as the superior; it however exists more frequently than it is absent, and in the proportion of 3 : 1, judging from our dissections; it is sometimes extremely small, and sometimes deficient. It is never oblong, but always broad and slightly flat. When deficient, we sometimes, but not always, find in its place two inferior cervical ganglions, in which case consequently, it is only situated lower than usual. Sometimes, but much more rarely, it is double, that is, it is divided into two small ganglions, a superior and an inferior, the former of which is then situated higher than the common single ganglion.

Its branches go upward, outward, inward, forward, and downward.

The *superior* unites it to the superior cervical ganglion, which we have already described.

The *external* are sometimes reduced in number to one, anastomose with one or more of the inferior cervical pairs, especially from the fourth to the sixth.

The *internal* accompany the inferior thyroid artery, on which they give rise to the *thyroid* plexus (*Pl. thyroideus*), extend to the thyroid gland, and go to join and enlarge the recurrent laryngœal nerve.

The *anterior* form the *middle or deep cardiac* nerve, the *great cardiac* nerve (*N. cardiacus medius*, s. *magnus*, s. *profundus*), which is the largest. Five or six filaments unite near the ganglion, first into two or three fasciculi, then in a trunk which descends obliquely from without inward, first along the primitive carotid artery, then before the subclavian, anastomoses in its course by several filaments with the trunk of the pneumo-gastric nerve, and with its recurrent branch, and unites with the inferior cardiac nerve to form the cardiac plexus.

The middle cardiac nerve differs on the right and left sides.

That of the right side, after passing before the subclavian artery, descends along the trunk of the innominata, unites at its bifurcation by a small ganglion with one or two twigs of the pneumo-gastric nerve,

and then passes between the arch of the aorta and the bifurcation of the trachea.

That of the left side arises by several filaments from the middle cervical ganglion, and from the inferior ganglion by one or two filaments which are larger than the preceding. The two ganglions then unite in this place, while on the right side they remain separate. The two roots unite some distance from the origin of the subclavian artery. The trunk passes behind the arch of the aorta, there unites to some filaments of the pneumo-gastric nerve, and anastomoses with that of the right side, and likewise with the two inferior cardiac nerves, to form the cardiac plexus.

The inferior branches are very minute, shorter than the rest, and five or six in number. They descend on the right side before and behind the subclavian artery, on the left side before and behind the trunk of the aorta, and anastomose with the superior ascending branches of the inferior cervical ganglion.

Sometimes the anterior of these branches are deficient, and the posterior also are united in a short common trunk, which establishes a direct connection between the two cervical ganglions.

C. INFERIOR CERVICAL GANGLION.

§ 1890. The *inferior cervical* ganglion (*G. cervicale inferius*) is much more constant than the central, and is generally flat, rarely rounded and oblong, often very irregular, and sometimes double. It is situated before the transverse process of the seventh cervical vertebra and the neck of the first rib, but sometimes descends to the second rib.

Its *superior* branches anastomose with the inferior of the middle ganglion. One which is rather large, enters the vertebral canal, where it entwines around the vertebral artery, sends some filaments to the intertransversarii muscles, and terminates at the third or second cervical vertebra.

Sometimes this branch arises only from the filaments which anastomose with the brachial plexus.

The *external* are smaller, but numerous, surround the subclavian artery, and give ramifications to the muscles of the neck, and anastomose with the two or three inferior cervical nerves, and also with the first dorsal, sometimes even but more rarely with the second thoracic pair, when the inferior cervical ganglion is much developed.

The *internal* terminate principally in the longus colli muscle and the pulmonary plexus.

The *anterior* form the *inferior cardiac* nerve (*N. cardiacus inferior, tertius, s. parvus*), which generally exists only on the right side, while on the left it is only indicated by the inferior root of the great cardiac nerve. These branches frequently interlace before uniting in a single trunk. The latter descends first behind the subclavian artery, then before the innominata and the arch of the aorta, anastomoses often

with the pneumogastric nerve, gives some filaments to the vessels situated near its course, and goes to the left between the aorta and the pulmonary artery, and terminates in the anterior cardiac plexus.

CARDIAC PLEXUS.

§ 1891. The *cardiac plexus* (*Pl. cardiacus*) is formed principally by the middle cardiac nerve. It is situated between the arch of the aorta and the bifurcation of the trachea. It extends from the division of the pulmonary artery to the origin of the innominata.

Its anterior filaments go principally to the anterior wall of the aorta, and the porterior to the pulmonary plexus. The inferior are more numerous, and go almost exclusively to the heart, where they form the two *coronary plexuses* (*Pl. coronarii*), in which also terminate some filaments of the inferior, and more generally of the superior cardiac nerve.

The *posterior coronary* plexus is much larger than the anterior; it goes to the base of the heart, descending on the left pulmonary artery. It is distributed to the lower and posterior part of the left ventricle, along the posterior coronary artery and its branches.

The *anterior* follows the course of the left *inferior* cardiac nerve, in its whole extent, passes between the aorta and the pulmonary artery, and after anastomosing at its upper part with the posterior, attends the anterior coronary artery and its ramifications, on the upper face of the heart and the right auricle, where it frequently anastomoses with the posterior, along the posterior edge of the organ. Some smaller twigs of this plexus proceed on the left pulmonary artery, and go to the pulmonary plexus of the left side.

The two plexuses frequently anastomose with some branches of the pneumo-gastric nerve.

They are, however, mostly formed by the ganglionnary nerve,

After leaving the lower part of the neck, the ganglions of the great sympathetic nerve are more numerous.

D. THORACIC GANGLIONS.

§ 1892. We find in the chest between the transverse processes of each two vertebræ, and on each side, a ganglion called the *thoracic* (*Gl. thoracicum*). These ganglions are generally slightly rounded, elongated, triangular, and fusiform. They are situated more on the outside than the cervical. The first counting from above downward (*G. thoracicum supremum*) is the largest of all the limiting ganglions except the superior cervical. Sometimes it is blended with the second; this, however, is rare, and even when it appears, generally exists on the outside. The middle ganglions are often a little smaller than the superior and the inferior.

All these ganglions are united to each other by one very strong filament, rarely by two.

The superior is almost constantly attached to the inferior cervical nerve by two filaments, the anterior of which not unfrequently divides in turn into two smaller filaments. Each thoracic ganglion anastomoses on the outside by two filaments, with its corresponding thoracic nerve. Internally, the superior gives off branches, some of which go to the lower part of the longus colli muscle, others to the cardiac plexus, several to the pulmonary plexus, which, however, is principally formed by the pneumo-gastric nerve; finally, some proceed to the aorta.

I. SPLANCHNIC NERVE.

§ 1893. From the inferior thoracic ganglions, and from their filaments of union, generally from the sixth or the seventh to the eleventh, arise cords, the upper of which are usually the largest; they vary in number from three to seven, and are very rarely the same on both sides of the body; they unite at an acute angle near the diaphragm, to form the *splanchnic* nerve, *grand surrenal*, Ch. (*N. splanchnicus*). This nerve descends behind the pleura, and generally goes from the chest into the abdomen, between the inner and middle prolongations of the pillar of the diaphragm, sometimes also through the aortic opening. It anastomoses in the abdomen, principally with the semilunar ganglion of its side, sometimes, directly, sometimes indirectly, by some small ganglions. It then forms the principal mode of union between the central portion of the ganglionnary nerve and the limiting ganglions. Not unfrequently some of the roots by which it arises, particularly the inferior, go separately to the semilunar ganglion, and some of them often anastomose, not with this ganglion, but with some filaments of the solar, the hepatic, the splenic, and the two renal plexuses.

II. SMALL SPLANCHNIC NERVE.

§ 1894. Two or three inferior branches, which, however, remain distinct, sometimes unite on the right side more frequently than on the left, in a small special trunk, called the small *splanchnic* nerve, *petit surrenal*, Ch. (*N. splanchnicus minor.*) This trunk passes through the pillar of the diaphragm below the preceding. It is enlarged by some filaments from the superior lumbar ganglions, and goes principally into the renal plexus, which is often in great part formed by it.

E. ABDOMINAL GANGLIONS.

§ 1895. The cord by which the limiting ganglions unite is always very small below the origin of the splanchnic nerve. Sometimes it is entirely deficient in some points, so that the trunk of the great

sympathetic nerve is there interrupted* and the limiting ganglions form one and the same series with the abdominal ganglions and plexuses only by intermediate connections. When this series comes on the lumbar vertebræ it goes forward. We there see ganglions which are much smaller, more remote from each other, and less constant in their situation than those hitherto examined. The upper is always larger than the others, which gradually diminish from above downward and often do not exist, or at least are almost invisible.

The upper pelvic ganglions of the limiting cord are a little larger than the inferior lumbar, and form a series which converges from above downward. There are usually four or five, the lowest of which is situated forward between the sacrum and the coccyx, and anastomoses with the corresponding ganglion of the opposite side by a shortened thin filament which is convex downward.

The lumbar and pelvic ganglions are united by some filaments which differ from those existing between the others in their length and also in their number and size; for there are usually three or four between each two ganglions, which are much smaller than those between the superior ganglions.

Their *external* branches proceed to meet the lumbar and sacral nerves, and anastomose with their anterior branches near the intervertebral and sacral foramina.

Those of the superior lumbar ganglions have a direction oblique from below upward.

The middle are transverse, and the superior oblique from above downward. The latter are very long, the first very short. Some which are smaller go upward to the psoas muscle, downward to the pyramidalis and to the levator ani muscles.

The lumbar ganglions give off some *internal* branches which go to the anterior face of the aorta, and contribute to form the *aortic plexus* which comes from the superior mesenteric plexus. Some of the sacral ganglions anastomose together before the sacrum; others terminate in the hypogastric plexus.

The series of limiting ganglions terminates below in some filaments which radiate from the last of them, and which are distributed in the lower and posterior part of the rectum.

§ 1896. Our mode of describing the ganglionnary nerve differs from that hitherto adopted even by those anatomists who consider it as directly opposed to the rest of the system, for they generally commence by that part which descends along the vertebral column, by the external ganglionnary cord, and terminate with the central portion.

* This has been seen twice by Haller, (*Elem. phys.*, vol. iv. p. 261). Bichat has also made this remark (*Rech. phys. sur la vie et la mort*, p. 82), and uses this as the principal argument in favor of his opinion, that the sympathetic nerve does not form a continuous trunk from the head to the pelvis. Wrisberg (*Obs. anat. de ganglio plexuque semilunari*, § 19, in the *Comm. Gœtting*, 1779, vol. ii. p. 102) has admitted this arrangement to be an anomaly, and Weber (*Anat. comp. nervi sympath.*, p. 122, regards this observation as doubtful.

Our course will at first view be more surprising, because we have several times mentioned that there is no manifest contrariety between the two nervous systems.

In fact the ganglionnary nerve is only the highest development of a form which has passed through several gradations. We may consider the diaphragmatic nerve as the first of these; this arises from several cervical pairs, and passes some distance to go to a voluntary muscle, the diaphragm, the principal agent in respiration. This formation is still more developed in the four posterior cerebral nerves, particularly in the pneumo-gastric, which forms plexiform anastomoses with the superior cervical nerves, descends along the neck, is distributed to the organs of respiration, and descends to the stomach in the abdominal cavity. The whole course of this nerve favours our analogies still more, inasmuch as it forms numerous plexuses whence branches proceed to the organs.

The ganglionnary nerve, if we except some filaments which arise perhaps from the pituitary gland, does not commence directly at the centre of the nervous system, but from several of the cerebral and from all the spinal nerves. It descends lower than the pneumogastric nerves, gives some filaments to all those organs of vegetative life which receive none from this latter, and frequently anastomoses with the two preceding. The plexiform and ganglionnary structure is more evident in it than in any other nerve, so that even the inner part of its expansion exceeds the outer; and hence from its form, situation, and connections with the encephalon and spinal marrow, it may be regarded as the trunk of the nerve, as is generally admitted, and thus the inner part is considered the central portion.

These are our reasons for departing from the common course, although the anatomical and the physiological relations of the ganglionnary nerve prove that it is dependent on the centre of the nervous system, being connected with it by its outer part.

CHAPTER IV.

DIFFERENCES PRESENTED BY THE NERVES DURING THEIR DEVELOPMENT.

§ 1897. The differences presented by the nerves during their development have been but slightly studied, and we have but few observations which refer to them. Not having had sufficient opportunities of obtaining well-preserved human fœtuses, we cannot add as many remarks as are desirable to those already existing.

We may state on this subject the following corollaries:

1st. All the nerves are not developed with equal rapidity in respect to color, texture, and consistence. The spinal generally increase

faster than the cerebral nerves. We have found them perfectly white and evidently fibrous in the fœtus of six months, while the cerebral nerves were grey. The fibrous texture and color are developed latest in the optic nerves. At six months it is much larger than the other encephalic nerves, and even at the ninth month of pregnancy it is still as grey as the rest of the cortical substance, is very soft, and presents no appearance of fibres. We have not yet been able to determine if it whitens before birth; it however experiences this change early, for in two children one month old we have found it perfectly white in all its course, except most of the portion between the decussation and the eye; the latter was entirely white before the decussation, grey on the outside and white on the inside in the centre; finally, totally grey forward.

We may conclude from these facts that the nerves complete their development from within outward and from behind forward. This proposition applies both to the different nerves and to the same nerves in different parts of the body. It is then very curious that the olfactory nerve which is the most anterior remains almost entirely grey during life, and constantly preserves this tint in its whole anterior part. This law seems to be general, for we have since met with it in fœtuses of the hog and cat.

We have also found the great root of the trifacial nerve entirely grey in the fœtus of eight months.

2d. The following remarks are applicable to the other differences presented by the nerves.

Among the spinal nerves we have found in a great many fœtuses the crural nerve divided on emerging from the pelvis into its tibial and peroneal branches, which were the more distinct the younger the fœtus.

Before the end of the fifth month of pregnancy they were not united so intimately as they are at an advanced age; hence this arrangement, which is abnormal in the adult, is normal during the early periods of existence.* We have not been able yet to observe any difference in the other spinal nerves.

The trifacial nerve differs from what it is in the adult:

1. In the number of its cords, which are at first fewer. In the fœtus of eight months there are only eighteen in the large root, while there are from twenty-eight to thirty in a child when born.†

2. The texture of its ganglionnary plexus is less fibrous. We have found the structure of this plexus was homogeneous at the sixth month of pregnancy.

These two peculiarities may be referred to the same principle, the imperfect development of the nervous tissue.

* We have already said that this arrangement is curious as analagous with the mammalia, but did not intend to assert that it is common to all these animals.

† Vesling, *Obs. anat.*, no. viii.—Sœmmerring, *De basi encephali*, § 69.—Niemeyer, in Reil, *Archiv. für die Physiologie*, vol. xi., p. 54.

The olfactory nerve is at first proportionally much larger; at the same time it is rounded, thicker, and shorter.

Until the sixth month there is within it a cavity which communicates with the lateral ventricles of the cerebrum.

These are two remarkable analogies with the mammalia.

In the full grown fœtus its external root is evidently medullary. We perceive also some medullary striæ on the lower face of the nerve, but there is no trace of the medullary band which represents its internal root.

In the early periods of fœtal existence, the great sympathetic nerve is more developed in proportion to the body than almost any other part of the nervous system. It is very remarkable that the large limiting ganglions are so near each other, particularly in the chest, that they form an uninterrupted series. The splanchnic nerve is also proportionally much thicker than in the adult

At about the middle of fœtal existence this nerve has diminished much, and then presents very nearly the proportions which continue during life.*

CHAPTER V.

PARALLEL BETWEEN THE DIFFERENT NERVES.

I. BETWEEN THE SPINAL AND THE ENCEPHALIC NERVES.

§ 1898. The spinal and encephalic nerves are generally strictly opposed to each other, and are distinguished by characters mentioned previously (§ 170); but the differences between them are not so distinct as is asserted. First those which truly exist do not prevent us from considering the encephalic nerves in the condition of spinal nerves, and from demonstrating that they are only modifications of the latter, and from investigating the cause of these modifications.

All the encephalic nerves are portions of spinal nerves which are not united in a single trunk like the latter, but are developed as so many separate nerves. This modification of the primitive type depends on the development of the centre of the nervous system within the skull and on that of the skull itself, which mechanically separates the different groups of the roots of the nerves at their origin and in their course.

It also depends on special organs, those of the senses, which are developed in the skull, the roots of which are formed by the nerves that go to them, and which are perfect in the direct ratio of the development of their special nerves. Comparative anatomy demonstrates, at least in regard to several organs of the senses, that new

* Lobstein has given a history of the evolution of the ganglionnary nerve in the fœtus, and the modifications it experiences as age advances (*loc. cit.*, p. 47-56.)

nerves are not formed for them,* but only that single branches arising from a special part of the encephalon become trunks. In fact we see several nerves, especially among those of the organs of the senses, which form separate trunks in superior animals, are only subordinate branches in the inferior animals. This is the case particularly with the trifacial nerve; and this is much more evident the more inferior the animal.

This development of portions of nerves which raises them to the rank of distinct nerves is gradually increased from the posterior to the anterior extremity of the cerebrum. It is manifested in the posterior pairs only by the want of union between the anterior and posterior roots; but the anterior roots seem to be formed from the fact that single fasciculi appear to be the proper nerves.

The nervous system then follows precisely the same type as the other systems, particularly the osseous; for the bones of the skull are more similar to the vertebræ the more posteriorly they are situated, and the dissimilarity between them and the vertebræ which gradually increases from behind forward, depends principally upon the fact that simple portions of the vertebræ have become sufficiently developed to be considered distinct pieces of bone.

In this view of the subject we should consider the last four cerebral pairs, the accessory, the pneumo-gastric, the glosso-pharyngeal, and the hypoglossal nerves, as so many sections of one and the same nerve, the posterior of which is formed by the first three nerves, and the anterior by the fourth. In fact, the accessory, the pneumo-gastric, and the glosso-pharyngeal nerves, arise by an uninterrupted series from the posterior cord of the spinal marrow, and emerge from the skull through the same opening. They thus form in the skull, trunks, the external parts of which are separate from each other, and generally pass through the dura-mater in different points. But this is far from being the case with the accessory nerve, and even when it is, the accessory is adapted to the pneumo-gastric nerve so intimately, that they form a single trunk. Beside, after the two nerves separate, the inner branch of the accessory nerve again unites with the eighth pair, and continues with it. The glosso-pharyngeal nerve also anastomoses by one filament, even within the cranium, with the pneumo-gastric nerve, and after leaving the skull, the communicate by several other filaments. It is curious that they accessory and pneumo-gastric nerves on one side, the glosso-pharyngeal nerve on the other, and just before where it unites with the two preceding, form ganglions near the place where they emerge from the skull,

* See on this subject the important memoir of Treviranus, in which he proves that the nerves of the fifth pair take the place of those of very important senses in some animals, and that there is in these animals some organs of sense very different from those of man, the nerves of which are the branches of the fifth pair (*Sur les nerfs de la cinquième paire, considérés comme organes ou conducteurs de sensations*; in the *Journ. complém. des sc. méd.*, vol. xv. p. 207). His observations have been confirmed since by Magendie. F. T.

exactly as do the posterior roots of the spinal nerves; nor ought we to omit mentioning that the posterior root of the superior cervical nerve often joins the accessory, which then assumes the character of the posterior root, which character is also expressed very distinctly by its situation behind the ligamentum denticulatum.

The glosso-pharyngeal nerve, the anterior root of this pair of nerves, arises from the anterior cord of the medulla oblongata, like the other anterior roots of the spinal nerves, and as its origin is situated more inward and forward, it also emerges from the skull through an opening situated more inward and forward. In fact, it leaves the skull through a special opening in the occipital bone, rather distant from that through which the other three pass. But this difference from the spinal nerves depends on the two causes mentioned above, and we see in it only a greater development of the arrangement in the anterior and posterior roots of the spinal nerves which pass through distinct openings in the dura-mater before uniting; finally, the glosso-pharyngeal nerve just after leaving the skull, is adapted directly to the trunk of the pneumo-gastric nerve, anastomoses with it by some filaments, particularly below its ganglion, and goes forward, while the eighth pair, united with the other two, is distributed principally below and backward. We ought not to forget that this nerve never forms the ganglion alone, and rarely or never communicates with the ganglion of the three posterior nerves.

The fasciculi of this nerve, like those of the first three, frequently emerge from the dura-mater, and sometimes from the skull, through distinct openings, but this difference is not essential, for if the fasciculi of each of the roots of the spinal nerves unite in man before that each root passes through the dura-mater, in the mammalia, they perforate this membrane in three or four points, and before uniting, as is also true of the nerves of which we speak. Comparative anatomy furnishes several other facts which prove the parallel stated by us. In fishes, the anterior and posterior roots of the spinal nerves emerge separately from the spinal column through special openings, so that they are still more similar to the cerebral nerves in this class of the animal kingdom. On the other hand, in most of the mammalia the first cervical nerve, and even the second in some, particularly the hog and the ox, frequently arise entirely from the anterior cord of the spinal marrow, and form only the anterior root of a spinal nerve, which does not emerge through a groove, but through an opening in the first and second cervical vertebræ. In almost all the mammalia the posterior root of the first cervical nerve enlarges into a ganglion long before it unites with the anterior, and before the nerve passes through the first cervical vertebra. The ganglion sometimes divides, as we have often observed in the hog for instance, into two enlargements, an anterior and a posterior, or at least we not infrequently observe a deep strangulation at its centre, and the portion of the posterior root between it and the part of the nerve where it emerges from the vertebral column forms two in the hog, an anterior

and a posterior; this shows that in this animal, except in the first cervical nerve, the posterior root tends to separate from the anterior, and to become a distinct and special nerve.

From all these remarks it is not difficult to reduce the last four cerebral pairs.

Sœmmerring had already remarked that the glosso-pharyngeal nerve appeared at its origin like each of the spinal nerves; hence it ought not to be separated from them and be considered an encephalic nerve.* The same anatomist compared the origin of the pneumo-gastric to that of the spinal nerves.† Finally, others had considered the accessory as a spinal nerve, or as making the transition from the spinal to the encephalic nerves. But each admits that these comparisons, founded on peculiarities which escape the eye, have no connection with the proposition we establish, viz. that the last four cerebral pairs form in fact only one encephalic nerve, the posterior root of which emerges through the intervertebral foramen, situated between the last and the last but one of the vertebræ of the skull (the occipital and the temporal bones), while the second emerges from it only through the last cephalic vertebra.

The reduction of the other eight pairs is more difficult. Some, however, the common and the external motor, evidently have the characters of anterior roots, or at least of portions of anterior roots; others, as the auditory and the superior motor nerve, present no less manifestly those of the posterior roots. It is more difficult to determine in regard to the rest. We may, nevertheless, compare the facial with the auditory nerve, and consequently with the posterior roots, on account of its course and the nearness of its origin, even as the origin and the course of the trifacial nerve authorize us to arrange it along the anterior roots. As to the two anterior pairs, the second may be compared to a posterior root, because it arises from the tubercula quadrigemina and the optic beds, and the first may be compared to an anterior root. We may then consider four pairs as anterior roots, and four as posterior roots, or as portions of these roots. It is now easy to refer the auditory, the facial, the trifacial, and the motor nerve, to a single trunk. When we follow the origin of the facial, trifacial, and auditory nerves within the cerebrum and backward, we see that they singularly approach each other. In regard to the facial and the auditory nerve, we must mention beside the nearness of their origins, the remark of Santorini, that we can trace below the transverse fibres of the annular protuberance, to the origin of the auditory nerve, some fibres which from their progress and direction, are evidently the commencement of the facial nerve.‡ The trifacial nerve which partly arises from the olivary bodies, blends here with the sixth pair. The common motor nerve goes from before back-

* *De basi encephali*; in Ludwig, *loc. cit.* p. 103.
† *Loc. cit.*, p. 101.
‡ *Septemdec. tab.* p. 23.

ward to meet all these nerves in the annular protuberance. The superior motor nerve and the optic nerve, are also very intimately united with them by the band which extends from the medulla oblongata to the tubercula quadrigemina.

The demonstration is most difficult with regard to the two anterior nerves; still the short distance between the origins of the external motor and optic nerves, indicates that the latter depends on the others, and the anterior commissure unites the olfactory and the optic nerves.

II. PARALLEL BETWEEN THE NERVES OF THE UPPER AND LOWER EXTREMITIES.

§ 1899. The nerves of the upper and lower extremities, like the ones, the muscles, and the vessels, are formed essentially after the ame type, and differ only by slight modifications of this type, which s subject to the same laws as those of the other three systems.

At first view the number of the pairs of nerves which unite to form he nerves of the two extremities, seem to differ considerably, as there re but five pairs of nerves of the upper extremities, while those of the ower are formed by ten. This difference, however, vanishes on strict xamination. In fact, all the cervical nerves are evidently arranged mong those which concur to form the brachial plexus, since they are ll united and changed into a real plexus like all the lumbar and acral nerves, by large anastomoses between their anterior branches. urther, the difference in number between the nerves of the two ex- emities is only one pair. But we may also explain this apparent nomaly by considering the last four encephalic nerves, the glosso- haryngeal, the accessory, the pneumo-gastric, and the hypoglossal erves as one pair, which corresponds to the branches of the inferior acral nerves. This comparison is authorized by the discussion in gard to the origin of these four nerves which we have mentioned, nd by considering the manner in which they are distributed. In ct, they give off branches to the tongue and upper part of the in- stinal canal, even as the inferior sacral nerves send them to the gans of generation and to the lower part of the intestinal canal.

All these analogies admitted, the number of pairs of nerves in the o extremities is equal: we must not, however, attach much im- rtance to this uniformity of number, nor consume time in endea- uring to establish it, for it is unimportant, but presents itself so turally, that it would be wrong to neglect it.

We may also proceed in an opposite manner, and decompose the perior and inferior plexuses, considering separately the deep rvical and brachial plexuses above, and the lombo-abdominal and cral plexuses below, and oppose them to each other. This is chat's method. But it is inferior to the other, because it obliges to separate parts which are united.

The principal common relations between the nerves of the two tremities in their distribution, are as follow:

The superior cervical nerves are distributed to the muscles and integuments of the neck, the same as the superior lumbar nerves are to the muscles and skin of the loins. The first sends some branches to the skin of the shoulder, the suprascapular nerves, while the second furnish some to the skin of the haunch and the arms.

The thoracic nerves correspond to the obturator nerve by their high origin, their course below the bones of the same part, and their distribution to muscles which correspond.

The scapular nerve is the superior gluteal.

The axillary nerve is the inferior gluteal.

The nerves which are distributed lower in the two extremities differ much more, since two twigs, and even large branches which correspond in their mode of distribution, arise from different trunks. The branches, however, are the same, and we can easily explain their differences in respect to origin.

The nerves yet to be compared are in the upper extremity, the internal and the external cutaneous nerve, the radial, the median, and the ulnar nerve; in the lower extremity, the crural and the sciatic nerve.

The external cutaneous radial nerves correspond to the crural: the internal cutaneous, the median, and the ulnar nerve, to the sciatic.

The external cutaneous nerve and the long cutaneous branch of the radial nerve, are evidently the superior and inferior internal saphena nerves of the lower extremity, since they descend along the side of the thumb and of the large toe, which is the internal, and the upper limb is in a moderate degree of pronation, and is always so in the lower extremity when it is at rest.

The muscular branches of the crural nerve are the upper branches of the radial nerve. They are distributed in the extensor muscles of the leg, as the latter are in those of the fore-arm.

The analogy, however, between the radial and crural nerves ceases there. The lower branches given off by the latter are represented in the leg, but come there from the sciatic nerve.

The superior and posterior cutaneous nerves of this latter very evidently correspond to the upper branches of the internal cutaneous nerve of the arm, since they descend on the outer or fibular side of the little toe, as these latter do on the ulnar side of the little finger.

The tibial nerve corresponds principally to the median and a part of the ulnar nerve. The peroneal represents the lower part of the ulnar nerve, and still more that of the radial. We may compare the posterior cutaneous branch of the tibial nerve, which so frequently arises from the peroneal nerve, to some ramifications of the internal cutaneous brachial nerve.

The muscular branches given by this nerve to the leg correspond to those sent by the median nerve to the muscles of the fore-arm.

The superficial plantar nerve is represented by the superficial palmar branch of the median nerve.

The internal plantar nerve corresponds exactly to the palmar branch of the median nerve.

The external plantar nerve is represented by the palmar branch of he ulnar nerve.

The muscular branch of the peroneal nerve corresponds to the mus-ular branches of the radial and ulnar nerves of the fore-arm.

The cutaneous branch which is distributed in the back of the foot orresponds by its external twig to the dorsal branch of the ulnar erve, and by the internal to that of the radial nerve.

§ 1900. The differences here remarked may be easily explained:

1st. Some nerves which arise as distinct trunks in the upper extre-ity are one nerve in the lower.

2d. Some branches arise from different trunks.

These two anomalies depend on the general difference in the form f the two extremities.

1st. As the fibula, from its smallness and its want of articulation with e tibia, seems reduced in man to a simple constituent part of the ia; as several muscles of the leg are attached in a common ten-n, while others situated in the fore-arm in the upper extremity are und in the sole of the foot; as the external cutaneous vein of the lvic limb unites with the internal at the knee, while these two veins main distinct to the axilla in the upper extremity; finally as the teries often divide very high in the upper extremity, while this omaly is very rare in the lower, so likewise the nervous trunks ich separate very early in the arm, long remain united in the leg. Farther, the tibial and peroneal nerves are not only sometimes dis-ct in the pelvis as those of the upper extremity sometimes are in axilla; but also the cutaneous nerves of the arm are frequently ple branches of the three larger nerves. The difference mentioned ve in the crural nerve during its development, also establishes a ater analogy between the two limbs in the early periods of life than a more advanced age.

2d. The difference in origin depends partly on the preceding fact, tly also on the difference in the direction and situation of the two remities. If the arm is in the state of pronation, and thus possesses irection similar to that of the lower extremity, these differences explained with facility.

The radial nerve is then drawn up as high as the elbow, so that we y imagine it to terminate here, and that its lower part unites with ulnar nerve.

The antibrachial parts of the median and ulnar nerves are also roximated, and they blend in a single trunk which divides into branches at the palm of the hand.

BOOK VI.

SPLANCHNOLOGY.

§ 1901. Splanchnology, or the branch of anatomy which treats of the apparatus for the functions, includes the description of the most complex parts of the organism, those formed by the union of a greater or less number of simple organs or systems. We cannot consider these as belonging to the class of those already mentioned, as they differ too much from these latter or from each other. We must however remark that they may finally be referred in respect to their essential characters to the cutaneous and glandular systems.

In regard to their functions they may be divided into two classes, one of which establishes an immaterial, the other a material connection between the organism and the external world. The first are the *organs of sense,* the others are properly termed the *viscera.*

The *organs of the senses* perceive actively the impressions of qualities belonging to the body which they contribute to form, or to external objects. They transmit them to the brain by means of their nerves, and cause in this viscus the formation of *ideas*, that is, they there produce modifications of the principle of the mind, of which it is the immediate organ.

Some of the *viscera* receive foreign external substances, others remove all that vital powers have rendered useless, or separate parts proper to form similar new bodies, that is, they remove from the organism all that is useless and which cannot serve to preserve the species. Some of these organs, as the intestinal canal and the lungs, perform both of these functions at the same time; others, as the kidneys and genital organs, serve only for the excretory function; they all have this in common, that they form new substances, and that they thus preserve the individual in the normal state. The substance formed by the genital organs serves also and in a special manner to preserve the species.

However different the results and the mode of action of the organs of sense and the apparatus of formation may be, the first are in regard to mind exactly the same as are the second in relation to the body. Farther, the inferior senses, those of smell, taste, and touch, which are the bases of all, insensibly establish the transition from the superior senses, those of sight and hearing, to the proper viscera, both in respect to their form and situation, and to their mode of action. We may

also admit that the organs of sense and the viscera have several characters in common; these are:

1st. They are developments of the cutaneous system.

2d. They are mostly or entirely situated in more or less perfect bony cavities.

3d. They are prolonged outward by valvular folds of the skin which are provided with simple glands and hairs.

4th. There is only one or at most but two: in the former case they are situated so that the median line divides them into two equal parts; in the second there is only one on each side, a right and a left.

As the direct organ of the spiritual principle is that which we considered last, it is most convenient to examine first the organ of the most ntellectual sense, that of hearing, and next to treat of that of sight, hat of smell, and lastly the organ of taste, which forms a part of the igestive apparatus. After describing this apparatus we shall pass to he organs of respiration and of voice, then to those of the urinary seretion, and lastly to those of generation and the history of the fœtus.

SECTION I.

OF THE ORGANS OF SENSE.

§ 1902. All the *organs of the senses** are similar in the following aracters:

1st. *They are situated in the head.* The organ of hearing is placed farthest backward and belongs entirely to the skull; it is also uated the most on the side, and its two lateral portions are entirely tinct from each other. The cavity occupied by the eye is partly med by the bones of the skull and mostly by those of the face. at of the olfactory organ belongs still more to the face, in fact ost exclusively to it, since the ethmoid bones form less of the skull n of the face. The cavity of the mouth is formed only by the bones he face. The right and left portions also gradually approach each er from the organ of hearing to that of taste, so that they finally nd in the tongue.

d. *They are all connected by short and large nerves with the encelon.* The auditory is proportionally the shortest and largest nerve. rises from the *calamus scriptorius* as from a distinct cavity, so that

*. Molinetti, *Dissertationes anatomicæ et patholigicæ desensibus et eorum or-*, Padua, 1669.—Casserio, *Pantæsthesejon, hoc est de quinque sensibus liber. norum fabricam, usum et actionem continens*, Venice, 1699.—Haller, *De senin genere*, Gottingen, 1742.—Lecat, *Traité des sens*, Amsterdam, 1744.—Sœmming, *Abbildungen der menschlichen Sinnorgane*, Francfort, 1809.

no other nerve of the organs of sense is connected so intimately with the mass of the encephalon.

3d. *All receive their nerves from at least two pairs.* The larger nerve is termed the *nerve of sense*, and the smaller the *accessory* nerve. In the organs of hearing, smell, and taste, the nerve of sense forms as many distinct pairs, the auditory, optic, and olfactory nerves, while in that of taste it is only a branch of the trifacial nerve, which is also the common trunk of the accessory nerves; but this includes also the hypoglossal, the glosso-pharyngœal and the facial, the three motor and the ganglionnary nerves. The names of several of these nerves prove that the accessory nerves serve principally to excite the motions of the organs of sense. The olfactory nerve is the only one which is to a certain extent an exception to the rule, since its proper accessory nerves, like its nerve of sense, are distributed in the mucous membrane of the nose. The nerves of sense and the accessory nerves are not necessarily connected; these connections do not exist in the organs of sight and hearing. They are slight and probably inconstant in the organ of smell, and are well developed only in the tongue, which is the most similar to the general organ of touch.

4th. *The proper nerves of sense expand more or less evidently as a thin membrane*, which is covered directly by a fluid, above which is a tissue similar to the epidermis.

5th. *They all communicate by ducts more or less broad*, the prolongations of the internal cutaneous membrane which make part of them, and which perform a part as much more important in their organization the less they are developed. The more similarity there is between them, as between the organs of taste and smell, the more loose and extensive the communication, so that they really form but one in the early periods of life, at which time the roof of the palate which will separate the last two from each other is not yet formed. The communication between these two organs of sense and the others is more marked the nearer the fœtus is to its period of formation.

In fact, the cutaneons system is more or less evidently the prototype of all the organs of sense, and the external integuments are the seat of sensation, as the hand is that of the special modification of the general sensation termed the touch.

CHAPTER I.

OF THE ORGAN OF HEARING.

§ 1903. The *organ of hearing*,* or the *ear*, is situated at the centre of the side and the base of the skull within and on the surface

* Fallopius, in his *Obs. anat.*, Venice, 1561; *Opp. omn.*, vol. i., tr. ii.—Eustachius, *De auditus organo*; in the *Opusc. anat.*, Venice, 1564.—Fabricius d'Aquapendente,

of the temporal bone. This organ, the most noble and the most intellectual of the senses, belongs entirely to the skull. It is connected with the encephalon more directly, and is protected better against external injuries than any other of the senses.

It is formed of a considerable number of parts differing very much in their form and texture, and which may be divided generally into two sections, comprehending the *external* and the *internal* ear.

ARTICLE FIRST.

EXTERNAL EAR.

§ 1904. The *external* ear, *oricule*, Ch. (*auris externa*),* is formed ›y the cartilage of the ear, the cartilaginous portion of the external uditory passage, and several muscles which are attached to the dif-›rent regions of the auricular cartilage. All these parts are covered ›y the common integuments.

A. CARTILAGE OF THE EAR.

§ 1905. The *cartilage of the ear* (*cartilago auris*),† considered ›nerally, is formed like a short tunnel with a broad oval opening rger from above downward than from before backward. This rface is very uneven from several prominences and depressions ›ich circumscribe this opening.

visione, voce et auditu, Venice, 1688.—J. Mery, *Description exacte de l'oreille*, ris, 1681.—Duverney, *Traité de l'organe de l'ouie, conetnant la structure, les* *ages et les maladies de toutes les parties de l'oreille*, Paris, 1683.—C. G. Schelmmer, *De auditu liber unus*, Leyden, 1684. A. M. Vasalva, *Tractatus de aure* *mana*, Bologna, 1704.—R. Vieussens, *Traité de la structure de l'oreille*, Tou-se, 1711.—J. F. Cassebohm, *Tractatus quatuor de aure humanâ*, Halle, 1734; *actatus quintus et sextus*, Halle, 1735.—Morgagni, *Ep. anat.*, ep. iv., v., vii., xii., i.—Geoffroy, *Dissertations sur l'organe de l'ouïe de l'homme, des reptiles et des* *ssons*, Amsterdam, 1788.—C. P. C. Wildberg, *Versuch einer anatomisch-physio-isch-pathologischen Abhandlung über die Gehörwerkzeuge des Menschen*, Jena, 5.—Sœmmerring, *Abbildungen der menschlichen Gehörgane*, Francfort, 1806. . S. Schroeter, *Des menschliche Ohr, nach den Abbildungen Sœmmerrings ver-ssert dargestellt*, Weimar, 1811.—J. Cunningham.—Saunders, *The anatomy* *the human ear, illustrated by a series of engravings of the natural size,* *h a treatise on the diseases of that organ, the causes of deafness, and their* *er treatment*, 1817.—C. S. Pohl, *Expositio generalis anatomica organis auditus* *classes animalium*, Vienna, 1818.—T. H. Weber, *De aure et auditu hominis* *nimalium*, Leipsic, 1820.—J. Van der Hœven, *Diss. de organo auditus in homine*, echt, 1822.

D. Santorini, *De aure interiori*; in the *Observat. anatom.*, Venice, 1724, ii.

B. S. Albinus, *De cartilagine auriculæ*; in the *Annot. academ.*, lib. vi., vii., tab. iv.

1st. The most external eminence which mostly surrounds all the others is called the *helix*.

It begins at the centre of the anterior edge of the external ear, goes first from below upward to the upper extremity of the auricular cartilage, then curves backward, and finally descends to the posterior part of the circumference of the ear, and terminates imperceptibly at its lower extremity.

2d. A second eminence surrounded by the preceding, and termed the *anthelix*. It begins below and behind near the lower extremity of the helix, goes upward and forward, separates a little from this latter and divides at its upper and anterior extremity into a superior and an inferior branch, which extend to near the ascending portion of the helix, where they gradually terminate.

3d. Opposite the commencement of the helix is a third square eminence which forms the anterior and inferior part of the cartilage of the ear. It is termed the *tragus*.

4th. Opposite the tragus we observe posteriorly a similar prominence termed the *antitragus* separated by a groove from the preceding. The helix and the anthelix terminate here.

§ 1906. The depressions between these different prominences are:

1st. The *scaphoid* or *navicular* fossa (*fossa scaphoidea*), a slight depression which is concave forward, convex backward, and which extends between the posterior part of the helix and anthelix.

2d. The *anonymous triangular* or *oval* fossa (*fossa anonyma*, s. *triangularis*, s. *ovalis*), which extends between the two branches of the anthelix.

3d. The *concha* (*concha auris*), a deep cavity which serves as the entrance to the cartilaginous portion of the auditory passage. It is situated between the helix, the tragus, and the antitragus.

4th. The *groove of the ear* (*incisura auris*), situated between the helix and the tragus.

§ 1907. The lower part of the external ear or the *lobule* (*auriculus*, s. *lobulus aurus*), has no cartilaginous frame. It is only a simple prolongation of the skin filled with fat and mucous tissue.

The cartilage of the ear extends at its lower part into a semicanal, which is open above and is termed the *auditory passage*, the *auricular* or *oricular* channel (*meatus auditorius cartilagineus*). This canal commences at the anterior part of the external ear, where it is more or less covered by the tragus like a valve. Its direction is at first transverse from without inward, or even a little from below upward: it then becomes in most of its course oblique from below upward and from before backward. It is terminated above by the long posterior root of the zygomatic process of the temporal bone, and below this root by some fibrous tissue.

The cartilage of the auditory passage, which is only a prolongation of that of the ear, is generally interrupted in some portions of its extent.

The principal space is in part where the direction of the passage is changed in the manner mentioned. There in fact the internal and external portions of its cartilage are not united above and below except by a narrow band.

The cartilage also presents at its external part a second smaller band, which descends from its upper edge and extends along its anterior wall.

The cartilaginous auditory passage is much shorter from before backward, than from above downward. It is about an inch long, four lines high, and three broad. Its inferior part extends inward and downward some lines farther than the upper.

It is attached to the adjacent parts of the temporal bone by a firm, short cellular tissue. Its internal orifice particularly unites to the asperities of the external orifice of the bony portion of the auditory passage, of which this cartilaginous portion is the continuation.

§ 1908. The cartilage of the external ear is entirely covered on its external and its internal face by the skin which intimately adheres to its inequalities. It gradually becomes thinner from without inward, moister and more analogous to a mucous membrane. The entrance of the auditory passage is generally furnished with short thin hairs which are arranged very compactly. The skin which lines it usually presents on its inner face a considerable number of broad rounded openings. These openings lead to a glandular and reddish layer, which surrounds them and secretes the *wax* (*cerumen aurium*), a thick, yellowish, viscous, very inflammable fluid, in which chemical analysis demonstrates a fatty oil, a peculiar albuminous and a coloring substance.*

B. MUSCLES OF THE EXTERNAL EAR.

§ 1909. The cartilage of the external ear is provided with several muscles† which are generally thin and small, and may be referred to two classes: one includes those which move the whole external ear, and thus contribute to change its situation and direction; the other is composed of those which move only some of its parts, and modify more or less evidently its general form.

I. MUSCLES WHICH MOVE ALL THE EXTERNAL EAR.

§ 1910. These muscles are the *attollens auriculæ* the *retrahentes auriculæ*, and the *attrahens auriculæ*.

* Berzelius observes (*Djurkmci*, vol. ii. p 230) that the cerumen ought also to contain water, and it is not well proved that the albuminous substance is truly of its nature. Rudolphi considers the bitter principle of the cerumen to be the same as that of the bile. F. T.

† D. Santorini, *Obs. anat.*, cap. i. tab. 1; *ejusdem Tab. posth.*, vol. i.—A. F. Walter, *Anatome tenuiorum musculorum corporis humani repetita*, with the table of Santorini.

a. Attollens auriclæ.

§ 1911. The *attollens auriculæ* muscle, the *superior auricular* muscle, *temporo-oriculaire*, Ch., the largest muscle of the ear, is thin and triangular. It arises from the centre of the aponeurotic envelop of the skull and the aponeurosis of the temporalis muscle, contracts from before backward, and is attached to the eminence of the auricular cartilage, which corresponds to the triangular depression between the two branches of the anthelix.

It elevates the ear, particularly during the action of the occipito-frontalis muscle, as it arises from the median tendon of this muscle.

b. Retrahentes auriculæ.

§ 1912. There are generally three *retrahentes auriculæ* or *posterior auricular* muscles, *mastoido-oriculaires*, Ch. Sometimes there are but two, more rarely four, the inferior of which is very thin. These muscles are always situated successively from above downward, are very small, thin, and elongated. They arise from the mastoid process, and are attached by short tendinous fibres to the centre of the external face of the ear, on the eminence which corresponds to the entrance of the auditory organ.

Their inferior extremity is often blended with the occipitalis, or with the complexus or the sterno-cleido-mastoideus muscles.

These muscles draw the ear backward, and slightly dilate the concha.

c. Attrahens auriculæ.

§ 1913. The *attrahens auriculæ* muscle, the *anterior auricular* muscle, *zygomato-oriculaire*, Ch., is also very small, but always a little larger than the preceding. It arises on the zygomatic process, goes backward and downward, gradually contracts, and is attached by a short tendon to the inferior and anterior transverse portion of the helix, which forms the commencement of this eminence.

It carries the ear forward and upward.

II. MUSCLES WHICH MOVE CERTAIN PARTS OF THE EXTERNAL EAR.

§ 1914. The muscles which move certain parts of the external ear are extremely small and weak, particularly in civilized nations. Being used but slightly or not at all, they cannot modify the form of the external ear, and may be considered as rudiments of those which are much more developed in animals. All are thin, and are attached by all their internal face to the part of the ear which they move.

They are the *tragicus*, the *antitragicus*, the *helicis major*, the *helicis minor*, and the *transversus auriculæ muscles*.

a. Tragicus muscle.

§ 1915. The *tragicus* muscle, *tragien*, Ch., is oblong. It arises from the inferior and anterior part of the concha, directly below the tragus, which it covers outwardly. Its superior edge is situated below the lower extremity of this eminence. It rarely goes farther, and extends to the lower extremity of the anterior edge of the helix, in which case it is even blended with the helicis major muscle.

It carries the tragus outward, and thus shows the orifice of the concha.

b. Anti-tragicus muscle.

§ 1916. The *anti-tragicus muscle*, *antitragien*, Ch., arises from the upper extremity of the external face of the antitragus, and is attached to the lower extremity of the anthelix.

It approximates these two eminences, and carries the antitragus a little backward and outward.

c. Helicis major muscle.

§ 1917. The *helicis major* muscle, *grand helicien*, Ch., is elongated. It arises from the inferior extremity of the helix, and ascends on the external and anterior face of this eminence, to which it is attached directly above the point where the ear separates from the head.

It draws the anterior part of the concha a little backward and downward.

d. Helicis minor muscle.

§ 1918. The *helicis minor* muscle, *petit helicien*, Ch., is the smallest muscle of the external ear. It is situated like the preceding, on the external face of the helix; it arises much lower and more posteriorly than it, in the place where this eminence leaves the external ear, and is attached sometimes higher to its ascending portion near the posterior edge.

It slightly depresses the anterior part of the helix.

e. Transversus auriculæ muscle.

§ 1919. The *transversus auriculæ* muscle, *transverse de l'oricule*, Ch., is situated on the internal face of the external ear, viz. that which looks towards the head. It is larger than the preceding, but is formed of fasciculi which are less coherent, and generally also less evidently fleshy. Its direction is transverse in almost all its course, and it extends from the anthelix to the scaphoid fossa.

It draws the scaphoid fossa and the helix outward, and thus enlarges the opening of the ear.

ARTICLE SECOND.

INTERNAL EAR.

§ 1920. The *internal ear* (*auris interna*)* comprehends:

1st. A considerable portion of the temporal bone, especially the petrous and mastoid processes.

2nd. The small bones of the ear, which moveably articulate with the temporal bone.

3rd. The muscles which move these little bones.

4th. A cartilaginous channel by which the ear communicates with the cavity of the mouth.

5th. A fibro-cartilaginous expansion contained within the bony portion of the ear.

6th. The auditory nerve which is distributed to this expansion.

A. EXTERNAL PORTION.

I. OSSEOUS PORTION OF THE AUDITORY PASSAGE.

§ 1921. The *osseous portion of the auditory passage, conduit auriculaire*, s. *oriculaire*, Ch., (*meatus auditorius osseus*), when perfectly developed, forms the posterior and external part of the lower face of the petrous process of the temporal bone. It is an elliptical canal, the direction of which is from above downward, from behind forward, and from without inward, which gradually contracts in the same direction. This canal is about half an inch long. Its height exceeds its breadth.

Its external orifice which presents grooves and asperities on its edge, is called the *external auditory foramen* (*porus acusticus externus, aditus ad meatum auditorium osseum*). It is turned from within outward, and is intimately united to the cartilaginous portion of the auditory passage.

Its posterior wall is a little shorter than the anterior. It is lined in its whole extent by a prolongation of the skin which covers the ear, and which gradually becomes thinner from without inward.

Its internal orifice presents a considerable depression, a groove in which the membrane of the tympanum is situated. This groove extends all around it, except its upper portion.

* C. Folius, *Nova auris internæ delineatio*, Venice, 1645.- B. S. Albinus, *De aure humana anteriore*; in the *Annot. acad.*, book iv., cap. ii.—A. Comparetti, *Observationes anatomicæ de aure internâ comparatâ*, Padua, 1789.—A. Monro, *On the brain, the eye and the ear*, Edinburgh, 1797.—Ribes, *Mémoire sur quelques parties de l'oreille interne*; in the *Bulletin de la soc. méd. d'emul.*, 1823, November, p. 650, December, p. 707.

II. MEMBRANE OF THE TYMPANUM.

§ 1922. The *membrane of the tympanum* (*mem. tympani*),* which is inclosed in the internal orifice of the auditory passage, separates the canal from that part of the internal ear which is next to it, that is from the cavity of the tympanum.

It is a thin, elliptical membrane, the direction of which is a little oblique from above downward, from without inward, and from behind forward. There is positively no opening in it in the normal state, although the contrary opinion has been maintained in several different forms.† It consequently completely separates the cavity of the tympanum and the labyrinth from the osseous portion of the auditory passage and from the external ear. As it extends a little farther than the opening which receives it, its form changes in regard to its degree of tension and relaxation,‡ which is produced principally by the action of the muscles of the little bones of the ear. It fits exactly into the groove at the internal extremity of the auditory passage.

Anatomists differ in opinion in regard to the formation of the membrane of the tympanum. The most correct consider it formed of a special membrane situated in the centre, of a second which is external, situated next to that of the bony portion of the auditory passage. In this view of the subject the external layers would be culs-de-sac of the internal and the external cutaneous system, while the middle layer forms a distinct and sepcial membrane arising from the bony portion of the auditory passage.

This special membrane presents very distinct fibres which radiate from its centre to its circumference, and are very manifest in its internal face. Judging from analogy, that is from what occurs, in the large animals particularly the elephant, these fibres are probably muscular.§ The most careful injections demonstrate also numerous blood-vessels which come principally from two circular trunks, an external and internal, and which anastomoses together frequently.

* A. F. Walther, *De membrana tympani*, Leipsic, 1725.—Brugnone, *Observations anatomiques sur la structure de la membrane du tympan et de celle de la ...se*; in the *Mém. de Turin.* an. xii. p. 1, 2.—E. Home, in the *Phil. trans.*, 1804.

† Very recently even Vest, judging from his own observations and those of ...ttmann, has maintained the normal existence of an opening in the membrane of the tympanum, admitted some time since by Rivinus, and long neglected. He ...erts that this opening is oblique, and thus forms a kind of valve. But he admits ...s frequently deficient (*Ueber die Wittmann' sche Trommelfellklappe*; in the *...dicinische Jahrbücher des Oesterreichischen Staates*, vol. v., Vienna, 1819, p. ...—133). To conclude from a few cases, which were probably morbid, that the ...ning is formed primitively, is evidently to make the exception a rule. F. T.

‡ F. Savart, *Recherches sur les usages de la membrane du tympan et de l'oreille ...erne*; in the *Journal de physiol. expériment.*, vol. iv., p. 183.

§ Sir E. Home asserts he has found some muscular fibres in the membrane of the tympanum in the elephant. Their existence is at least doubtful. Rodolphi ...observed nothing similar in the whale or horse. F. T.

Of the two superficial layers the external is easily insulated: but it is more difficult to separate the internal from the middle both on account of its fineness and because it adheres to this latter more intimately.

B. MIDDLE PART.

I. TYMPANUM.

§ 1923. The *tympanum* or the *drum* (*tympanum*, s. *cavitas tympani*)* is a narrow, rounded cavity, which is generally convex internally, and which is continuous outwardly with the osseous portion of the auditory passage by a broad opening, before which the membrane of the tympanum is expended, and forward with the Eustachian tube through another narrow opening. This cavity forms the central part of the internal ear; hence some anatomists term it the *middle ear*, in opposition to the labyrinth and all the parts on the outside of it. It occupies the external and posterior part of the petrous portion, and communicates anteriorly with the cavity of the mouth, posteriorly with the mastoid cellules.

Its internal and very irregular face presents numerous elevations and depressions which are connected with the labyrinth. It incloses the little bones of the ear and the cord of the tympanum.

When we consider only the bones, we perceive that it is open forward, backward, and downward. A mucous membrane which is continuous with that of the throat lines its whole extent.

§ 1924. On the inner face of the cavity of the tympanum, forward and downward, at about its centre is a considerable eminence, termed the *promontory* (*promontorium*), formed by the commencement of the cochlea, and always covered by osseous substance.

At its lower and posterior part is an oblong, triangular opening, more high than broad, which is directed backward and outward; this is the *fenestra rotunda*, the *cochlear* opening of the *tympanum*.† This opening communicates with the cochlea, but it is closed by the mucous membrane which lines the whole cavity of the tympanum.‡

Above the promontory and little above the centre of the tympanum is a second and much larger opening, called the *fenestra ovalis*, the *vestibular opening of the tympanum* (*fenestra ovalis*, s. *semi-ovalis*). The length of this opening, the greatest diameter of which is directed from above downward and from before backward, exceeds its breadth.

* Santorini, *Opp. posth.*, tab. vi.

† A. Scarpa, *De structurâ fenestræ, rotundæ auris, et de tympano secundario anatomicæ observationes*, Modena, 1772.—Ribes, *loc. cit.*, p. 652.

‡ Ribes asserts that the membrane of the fenestra rotunda is composed of a special layer, of a second given off by that of the cavity, and of a third coming from that which lines the internal scala of the cochlea. Its structure then resembles that of the membrane of the tympanum. F. T.

its posterior edge is convex, the anterior is straight. It is surrounded outward by a small groove.

On the posterior wall of the cavity of the tympanum opposite the lower extremity of the fenestra ovalis, farther backward and much more outward, we remark the *pyramid* (*eminentia pyramidalis*), a small triangular eminence, which terminates forward by an opening which is grooved in it, and which communicates with the Fallopian canal: from the anterior extremity of this a small bridge of bone is frequently detached, which goes to the upper extremity of the promontory, below the fenestra ovalis.

Below and more posteriorly is another opening (*apertura chordæ*), through which the cord of the tympanum passes from the Fallopian canal to the tympanum.

The space between the pyramid, the promontory, and the fenestra ovalis forms a considerable depression, termed the *sinus of the tympanum* (*sinus tympani*).

Above and in the centre the cavity of the tympanum is grooved to receive the upper part of the two largest bones of the ear.

Upward and backward it communicates by one or more considerable openings with the cavity of the mastoid process, which must consequently be considered as a prolongation of it. This cavity is divided by numerous septa into cellules, which enlarge much from the centre to the circumference, and which are lined by the mucous membrane which covers the inner face of the tympanum.

The internal wall of the tympanum presents at its anterior part a groove which leads into an osseous prolongation; this extends forward, and is the *bony portion of the Eustachian tube* (*tuba Eustachii ossea*). Above this groove we observe a second, which sometimes is not separated from the other in its whole extent, and which lodges the tensor tympani muscle.

Under the posterior extremity of the second groove is a small opening which leads above to the superficial petrous groove, below to a groove which descends on the promontory. This groove becomes at its lower part a canal which opens outward on the lower face of the pyramid, between the carotid canal and the fissure of the jugular vein.

Through this canal passes a filament of anastomosis between the second branch of the trifacial, the glosso-pharyngœal, and the ganglionary nerve; this minute filament arises from the superficial petrous nerve, enters the cavity of the tympanum with another filament of the great sympathetic nerve, and communicates below this cavity with the ganglion of the glosso-pharyngœal nerve.*

* Jacobson, *Supplementa ad otoiatriam*; in *Act. Hafn.*, vol. v., 1318, p. 292.

II. EUSTACHIAN TUBE.

§ 1925. The *Eustachian tube, conduit guttural de l'oreille,* Ch. (*tuba Eustachii*), is a canal, the posterior part of which is formed of bone, but is fibrous and fibro-cartilaginous at its anterior portion, and extends from the tympanum to the upper part of the pharynx. The direction of this canal is oblique from above downward, from without inward, and from behind forward. It is nearly two inches long.

The osseous portion is the shortest, and is situated above the carotid canal. It becomes narrow from behind forward.

The cartilaginous portion proceeds directly below the base of the skull, but on the contrary gradually enlarges in the same direction. It is compressed from within outward in its whole extent. Its form is elliptical and it is fibro-cartilaginous in the inner portion, and sometimes also in the upper portion of its external wall. In other parts it is composed of a fibrous tissue, which arises from the periosteum of the inferior pterygoid process.

The Fallopian tube is entirely lined internally by a very fine mucous membrane, which is continuous with that of the oral cavity and of the tympanum. Around the buccal orifice of this tube this membrane becomes much thicker, partly from a great development of the muciparous glands. Thence a prominence is formed, which changes this opening into a narrow longitudinal fissure and forms a kind of valve.

III. BONES OF THE EAR.

§ 1926. The *bones of the ear* (*ossicula auditus*),* situated at the upper part of the cavity of the tympanum, are the smallest bones in the body. They form a chain composed of pieces moveably articulated with each other, which extends from the membrane of the tympanum to the fenestra ovalis, consequently to the labyrinth, and which conveys to the deepest parts of the internal ear the changes which supervene in the membrane of the tympanum.

There are three bones, the *hammer* (*malleus*), the *anvil* (*incus*), and the *stirrup* (*stapes*); and in the early periods of life a fourth, the *lenticular* bone.

* J. A. Schmid, *De periosteo ossiculorum auditus ejusque vasculis*, Leyden, 1719.—H. F. Teichmeyer, *Diss. medica solemnis sistens vindicias quorundam inventorum anatomicorum*, Leipsic, 1727.—Magendie, *Sur les organes que tendent ou relachent la membrane du tympan et la chaine des osselets de l'ouie dans l'homme et dans les animaux mammifères*; in the *Jour. de phys. expérim.*, vol. i., p. 341—347, tab. iv.

a. Malleus.

§ 1927. The *hammer* (*malleus*) forms the anterior and external part of the chain, and is divided into a *head*, a *neck*, a *handle*, and *processes*.

The *head*, the upper part, is rounded, oblong, convex and smooth forward, concave and slightly uneven backward. Its posterior face is oblong and surrounded by a slightly prominent edge. A transverse eminence divides it into an upper and a lower face.

The head is situated above the inferior edge of the membrane of the tympanum in the anterior part of the upper prolongation of the cavity of the tympanum.

The *neck* is short, compressed in all parts, but particularly slightly flattened from without inward.

Its lower extremity is divided into three sections, the *handle* and the two *processes*.

The *handle* (*manubrium*), or the inferior section, descends a little from without inward and from behind forward. It is terminated at its lower extremity by a small prominence, and is situated between the layers of the membrane of the tympanum.

The *external* or the *short process* (*processus externus*, s. *obtusus*, s. *brevis*) projects more or less at the upper extremity of the handle, and forms with it a right angle. It is directed outward, and is separated by a deep groove from the head, into which the upper side of the internal extremity of the auditory passage enters.

The *anterior long* or *spinous process* (*processus anterior*, s. *longus*, s. *spinosus*) is thinner but much longer than the preceding, and is convex above and concave below. It is received by a broad and superficial groove hollowed on the inner face of the upper extremity of the ring of the tympanum.

The malleus is connected with the membrane of the tympanum and with the incus.

b. Incus.

§ 1928. The *anvil* (*incus*) has nearly the form of a bicuspid molar tooth; it is composed of two branches and of a centre which may be termed the *body*.

The *body* is almost square, flat, and presents forward a concave surface, by which the bone articulates with the head of the malleus (§ 1926). It is situated above the membrane of the tympanum.

The *upper* or *posterior* and *shorter* branch is flattened from within outward, terminated by a blunt summit also situated above the membrane of the tympanum, and is directed horizontally from before backward, where its loose extremity terminates.

The *anterior* or *inferior* branch varies in length, and is almost straight; its direction is from above downward and from behind forward, and it is situated more internally than the preceding. It terminates in a small button-like prominence; it is situated behind the handle of the malleus, a little on the outside of it.

The body of the incus articulates above and forward with the head of the malleus, by its long branch below with the stapes. It is not directly connected with the membrane of the tympanum.

c. Lenticular bone.

§ 1929. The *lenticular* bone (*os lenticulare*, s. *Sylvii*) is an extremely small, flat, and rounded bone, situated on the inner face of the lower extremity of the long branch of the incus. It generally fuses with the incus very early, even during the latter months of pregnancy, and then forms an eminence which projects on its inner face.

d. Stapes.

§ 1930. The *stirrup* (*stapes*), is situated more internally than the other two bones of the ear, and is not perpendicular like them, but horizontal. It is composed of a *head*, two *branches*, and the transverse face or the *base*.

The *head* is rounded, oblong, and flattened from above downward. Its upper extremity looks outward and presents a slight depression for the lenticular bone: the two branches are sometimes separated by a contracted *neck*.

The *anterior* branch is always shorter and also straighter than the *posterior* branch. Both are grooved on their internal faces, which look towards a groove in which a membrane, a prolongation of that of the tympanum, extends between them.

The *base* has exactly the same form as the fenestra ovalis, with which it is movably united by the membrane of the tympanum. It is always a little narrower, so that it can enter and leave the vestibule through this opening.

Its inner face, which corresponds to the fenestra, is straight. The external is concave and circumscribed by prominent edges.

IV. MUSCLES OF THE BONES OF THE EAR.

§ 1931. The small bones of the ear are moved by four muscles, which, like the bones to which they are attached, are the smallest in the body. Three of these are inserted in the malleus and one in the stapes. Two muscles of the malleus are situated before the cavity of the tympanum, the third above this cavity. That of the stapes is situated behind it. The incus has no special muscle: it forms only a connecting link between the malleus and the stapes.

a. Muscles of the malleus.

§ 1932. The three muscles of the malleus, from their connections of he bone with the membrane of the tympanum, vary the degree of ension of this membrane. They are distinguished into an *internal* and an *external.*

I. Tensor tympani muscle.

§ 1933. The *tensor tympani* muscle, the *internal muscle of the ialleus* (*m. tensor tympani*, s. *mallei internus*) is elongated. It arises om the upper part of the cartilaginous portion of the Eustachian ibe near the sphenoid bone, and generally comes from its large wing. ts direction is from before backward in the canal from which the etrous process is grooved to allow it to pass to the osseous portion of ie tube. In the cavity of the tympanum the direction of its tendon hanges, leaves the internal wall of this cavity, goes outward and is ttached to the upper extremity of the inner face of the malleus irectly below its long process.

This muscle draws the malleus inward, tenses the membrane of the mpanum which the bone draws with it, and brings the chain of bones iward so as to sink the stapes into the fenestra ovalis.

2. Laxator tympani major muscle.

§ 1934. The *laxator tympani major* muscle, the *great external uscle of the malleus* (*M. laxator tympani major*, s. *mallei externus ajor*), arises from the grooved prolongation of the great wing of the henoid bone, and is directed from without inward and from before ickward. Its tendon enters the fissure of Glaser, and is attached to e long process of the malleus.

It draws the malleus forward and outward, and thus relaxes the embrane of the tympanum.

3. Laxator tympani minor muscle.

§ 1935. The *laxator tympani minor* muscle, the *small external mus- of the malleus* (*M. laxator tympani minor*, s. *mallei externus minor*), much smaller than the two preceding, and arises from the upper ge of the osseous portion of the auditory passage, passes between the yers of the membrane of the tympanum, goes forward and outward, d is attached sometimes higher and sometimes lower to the handle d the external process of the malleus.

It draws the malleus upward, backward, and outward. It conse- ently relaxes the membrane of the tympanum.

b. Stapedius muscle.

§ 1936. The *stapedius* muscle (*M. stapedius*) is oblong and triangular. It arises at the base of the pyramid, and goes forward and upward. Its tendon comes through the anterior opening in the top of the pyramid, and is attached to the posterior part of the head of the stapes.

It draws the stapes backward, so as to bring the posterior portion of its base into the fenestra ovalis. It also draws the chain of the bones inward, and thus tenses the membrane of the tympanum.

We have every reason to think that it acts at the same time as the tensor tympani muscle.

C. INTERNAL PORTION, OR LABYRINTH.

§ 1937. The *labyrinth* (*labyrinthus*),* the most internal part of the organ of hearing, comes next inside to the tympanum. It is a double cavity situated in the petrous portion of the temporal bone, directly surrounded by the very firm substance of this portion, and is formed of several compartments of very complex figures. We distinguish in it a *central* part the *vestibule*, a *posterior* part the *semicircular canals*, an *anterior* portion the *cochlea*, and the *lateral* parts the *aqueducts*.

One of the two cavities which form it completely surrounds the other and is moulded upon it.

The first is the *osseous labyrinth*, the second the *membranous labyrinth*.

I. OF THE OSSEOUS LABYRINTH.

§ 1938. The *osseous labyrinth* in the adult is not distinct from the compact substance of the petrous process of the temporal bone, of which it forms the most internal, the firmest and the hardest part, which closely envelops and covers the membranous labyrinth. But in the early periods of life it is formed by a solid, hard, and brittle substance, separated from the external layer of the petrous process by a less compact osseous tissue. Its internal face is moistened with limpid serum, which exactly fills all the space between it and the membranous labyrinth.†

During the early periods of life we find between the two labyrinths a membrane which is not the periosteum of the osseous portion, although generally considered as such, but which belongs to the class

* A. Scarpa, *Disquis. anatomicæ de auditu et olfactu*, Pavia, 1789.—A. Monro, *loc. cit.*—Brugnone, *Observations anatomico-physiologiques sur le labyrinthe de l'oreille*; in the *Mémoires de Turin*, 1805—1808, p. 167—177.

† Cotugno, *Diss. cit.*, § xxix.—P. F. T. Meckel, *De labyrinthi auris contentis*, Strasburg, 1777.

of sero-mucous membranes. This is demonstrated by the numerous vessels it receives, and by its abundant secretion and its connections with the membrane of the tympanum.

a. Vestibule.

§ 1939. The *vestibule* (*vestibulum*),* the middle of the bony labyrinth, is situated farther inward and more posteriorly than the tympanum. It is of a rounded and oblong cavity, at about the centre of which we perceive the internal orifice of the fenestra ovalis. We there remark principally two small depressions or superficial grooves, one *superior*, *posterior* and *external*, more extensive than the other and of an oval form (*fovea*, s. *cavitas ovalis*, s. *elliptica*, s. *semi-elliptica*); the other *inferior* and *anterior*, small and semicircular (*fovea hemisphærica*, s. *orbicularis*). The first is situated on the posterior and inferior wall, the second on the superior and external. They are separated by a sharp crest, which extends from above downward.

The oval fossa is continuous below with another which is smaller, the *sulciform* groove (*fovea sulciformis*).

§ 1940. In the circumference of the vestibule are six large foramina, and one which is rounded and very small.

Of these six large foramina, one which occupies the anterior and inferior part of the vestibule leads to the superior scala of the cochlea; the other five, situated at the posterior part, are the orifices of the posterior part of the labyrinth, or the semicircular canals.

The small opening at the posterior and inner part of the vestibule in the sulciform grooves leads to the aqueduct of the vestibule.

b. Semicircular canals.

§ 1941. The *semicircular canals* (*canales semi-circulares* form the posterior and largest part of the labyrinth.

There are three of them which occupy a square space: the *superior* or *anterior*, the *posterior*, *internal* or *inferior*, and the *external*. The first two are prependicular, the third is horizontal.

When united they form more than half a semicircle. They are much more prominent at one of their extremities than at the other and in the rest of their course, so that they represent in this place a rounded vesicle (*ampulla*). They are not perfectly round externally nor internally, but are slightly flattened and elliptical.

The diameter of their cavity is about half a line.

Their orifices are a little broader than the rest of their course.

The *superior* is oblique from without inward and from before backward. It forms the highest part of the labyrinth, and its two branches are separated the farthest. Its anterior and external opening, which

* Ribes, *loc. cit.*, p. 651.

is situated above the fenestra ovalis, forms a considerable vesicle, of which we see another trace at its posterior extremity, through which it blends with the superior opening of the internal canal.

The *inferior* is also perpendicular, but its convexity looks backward and its concavity forward. It commences above by a short canal which it has in common with the internal extremity of the superior, and terminates by a vesicular enlargement below and inward in the vestibule.

It is the longest, and its branches are nearest each other.

The *external* or *horizontal* arises by a slightly marked vesicular prominence below the external orifice of the superior. Its internal orifice in the vestibule is situated on the outside and below the common opening of the superior and the inferior.

It is the shortest and also the broadest of the three semicircular canals.

The reunion which occurs between the superior and inferior canal, diminishes the number of the openings of the semicircular canals to five, instead of six.

c. Cochlea.

§ 1942. The *cochlea* * forms the anterior and most complex part of the labyrinth. It presents to a certain extent the repetition of the semicircular canals, and its figure perfectly resembles that of the shell-fish whose name it bears.

It is a grooved canal which gradually diminishes from its origin to its extremity, and thus it finally becomes very narrow. It turns around a central and perpendicular portion termed the *axis* (*modiolus*), which gradually becomes thinner. It thus describes two turns and a half.

The first turn is much larger than the rest, which it envelops; the others however project much beyond it.

§ 1943. A horizontal plate of bone, which arises from the inner part of the cochlea and which is termed the *spiral septum* (*lamina spiralis*), divides it into two canals situated one above the other and termed the *scalæ*.

The lower face of the *spiral septum* presents grooves which look towards the axis. Its upper face is the smoothest.

It is formed of two laminæ, a superior and an inferior.

* G. Brendel, *De auditu in apice cochleæ*, *Program. I. II.*, Gottingen, 1747.—J. G. Zinn, *Observationes de vasis subtilioribus oculi et cochlea auris internæ*, Gottingen, 1753.—J. G. Ilg, *Einige anatomische Bemerkungen, enthaltend eine Berichtigung der zeitigen Lehre vom Bau der Schnecke des menschlichen Gehörorgans, nebst einer anatomischen Beschreibung und Abbildung eines durch ausserordentliche knochenwucherung sehr merkwürdigen menschlichen Schädels*, Prague, 1821.

The *inferior lamina* is much broader than the superior, and terminates backward and outward in the fenestra rotunda in the tympanum. This has been termed the *scala of the tympanum* (*scala tympani*). It is separated from the cavity of the tympanum by a membrane which presents a depression on the side of this cavity, which is termed the *secondary tympanum* (*tympanum secundarium*).

The *superior scala* is much narrower than the inferior. It terminates at the anterior opening of the vestibule. Thence it is termed the *scala of the vestibule* (*scala vestibuli*).

The cochlea however does not continue separated the entire length of this cavity, and the spiral septum terminates near the middle of the second turn in a pointed hook, termed the *hook of the cochlea* (*hamulus cochleæ*).

By uniting in this manner, the two canals of the cochlea give rise to a tunnel-like cavity, the *infundibulum* (*scyphus*), the base of which is turned upward and the summit downward towards the cupola of the cochlea.

This conical cavity forms the most prominent part of the cochlea.

The *axis*,* which turns on itself, is hollow like the scalæ. A larger canal passes longitudinally through it from its base to its summit. It also presents numerous small openings, the diameter of which gradually diminishes from its base to its summit. These openings lead to small canals, which terminate on the spiral lamina.†

* Rosenthal, *Sur la structure de l'axe du limaçon dans l'oreille de l'homme*; in the *Journal complém. du Dict. des sc. méd.*, vol. xvi., p. 180.

† Anatomists have hitherto considered the axis of the cochlea as a small column rmed by a very thin osseous lamina, through which a canal passes from the base the summit, which is perforated by numerous small foramina. It is asserted that terminates at the second turn of the cochlea, at the top of which it appears on ving this place as a tunnel-form layer of bone, the summit of which is the termi- .tion of the axis, and the upper extremity of which looks towards the summit of e cochlea and is covered by a plate of bone. Hence are distinguished the cavity of e axis and that of the infundibulum. There is also admitted in the latter a thin lumn around which the spiral septum turns from the second curve, and which rminates in a small osseous plate curved like a hook. Ilg describes the structure this axis differently. He states that the spiral channels of the cochlea do not turn ound a special nucleus of bone; hence he does not admit an axis, but asserts that the inner and concave wall of the spiral canal which forms the species of column ound which this canal turns, and that we perceive in it the form of a cylinder on ning the first and second turn of the cochlea. The column is very thick in the st turn where it is a line and a half in diameter, but very thin in the second, where diameter does not exceed half a line. As the internal wall of the spiral canal ms what is termed the axis in the first two curves, so likewise it produces someng similar in the third. But this pillar of the third turn has not the form of a inder; it is composed only of a very thin and twisted osseous plate, which arises n the summit of the cylindrical column and extends to the cupola of the cochlea, ere it is attached. The loose edge of this plate, which exists all the length of the ginary axis of the cochlea, from the termination of the cylindrical column to the of this cavity, is smooth, rounded, and generally a little concave in the direction ts length. Sometimes also it represents a small column which goes directly to summit of the cochlea. The axis of the column is perforated by a small canal, this column is filled to the second turn by an osseous cellular mass, the cellules hich communicate with numerous small foramina grooved along the parietes of column, and into which open some small canals which proceed between the two rs of the septum or spiral lamina. Rosenthal has since modified and rectified the

d. Aqueducts.

§ 1944. The *aqueducts* (*aquæductus, diverticula,*)* of the labyrinth are short, narrow canals, which are directed from above downward through the substance of the petrous process of the temporal bone, and which enlarge a little in their course. There are two, the *aqueduct of the vestibule*, and the *aqueduct of the cochlea.*

The *aqueduct of the vestibule* (*aquæductus vestibuli*) begins by a very small opening in the inner wall of the vestibule before the common opening of the two perpendicular semicircular canals in the sulciform groove of the vestibule, which is in fact their internal orifice. It first goes a short distance from without inward and a little from below upward in the centre of the petrous proces, then from above downward, insensibly enlarges on leaving this curve, and after proceeding about four lines terminates a little behind the centre of the inner face of the petrous process of the temporal bone near the fossa intended for the gulf of the internal jugular vein, with which it always communicates by a slight groove.

The *aqueduct of the cochlea* (*aquæductus cochleæ*) commences by a wider opening in the tympanitic scala of the cochlea directly before the fenestra rotunda, descends from before backward, enlarges in this course, and terminates by a triangular opening at about the centre of the inferior edge of the petrous process of the temporal bone.

By these two aqueducts the membranous labyrinth communicates externally,† and forms culs-de-sac between the bone and the dura-mater.

description of Ilg. It follows from his researches, that from the summit of the pillar of the first two turns a layer proceeds in a semicircle to the external wall, and terminates by a loose and semilunar edge, which ascends to the infundibulum. The last turn is open on the side of this edge, by which the lamina turned opposite the pillar terminates, and the unciform extremity of the spiral lamina which is reflected around the same edge projects in the turn in question; the two laminæ terminate in this place, or rather blend in this small rounded cavity. The crook turning round the edge of the lamina of the axis in the place where this lamina separates from the centre of the pillar, is like the extremity of the latter, separated from the infundibulum. The edges of the spiral lamina and of that of the pillar are fitted to each other, cross so that their faces are turned from the side of the external wall of the cochlea, and as the latter inclines a little towards the centre of the pillar, they form in some measure a broad tunnel-like edge for the canal grooved in the first two turns of the column to emerge. It follows then from Rosenthal's description: 1st, that, as Scarpa and some other anatomists have asserted, the base of the infundibulum is situated on the summit of the cochlea and its summit in that of the pillar, but it does not extend so deeply as they assert, for it terminates below the last semiturn and is loose below the cupola of the cochlea, and there is no extended lamina of the column which unites with its covering; 2d, that Ilg is mistaken in saying that the axis extends to the centre of the cochlea, to its roof, and that it does not form a tunnel-like edge, and is attached to the summit of the cochlea by a rounded point closed at its extremity. F. T.

* D. Cotugno, *De aquæductibus auris humanæ internæ anatomica dissertatio*, Naples, 1761.—P. F. Meckel, *De labyrinthi auris contentis*, Strasburg, 1777.—Ribes, *loc. cit.*, p. 713.

† The opinion that the aqueducts establish the communication between the labyrinth and the exterior was admitted by Cotugno, who, thinking that the inter-

They also serve for the passage of the arteries which enter the labyrinth and the veins which come from it and the lymphatics, the absorbent action of which prevents the abnormal accumulation of serum in this cavity. The veins, and perhaps some of the lymphatics also, empty into the internal jugular vein. This explains why mercury and other fluids pass from the labyrinth into this vein through the aqueducts, after distending the sacs of the membranous labyrinth.

nal ear is always exactly filled with serum, had been obliged to explain how this liquid can be moved by the compression exercised upon it by the base of the stapes, to suppose the existence of derivative canals, which allow it to escape in part, and to leave a certain space between it and the parietes of the ventricle. The observations of Brugnone and of Ribes, which we shall mention hereafter, overturn all this theory. These anatomists consider the pretended aqueducts only as passages for the arteries and veins. In regard to that of the vestibule, Ribes has discovered that at about the centre of the posterior face of the petrous portion of the temporal bone, where it begins as an uneven and undulating layer, it goes forward, upward, and outward, proceeds first on the inside of the posterior semicircular canal, next between the posterior wall of the vestibule and the superior semicircular canal, curves and penetrates into the concavity formed by this canal, thence goes backward and outward, and is distributed in the spongy tissue of the posterior part of the labyrinth. This duct is at first very broad, and it contracts much in its course upward. It generally gives off in its course other smaller ducts, at each of which it becomes smaller, and among which Ribes has found some which opened into the inner part of the vestibule, others into the posterior semicircular canal, but only in three pieces, for in all others there was no duct from the aqueduct proceeding either within the vestibule or to any other point within the labyrinth. Besides this aqueduct does not exist in the full grown fœtus nor even some time after birth. It is designed to contain the blood-vessels which ramify in all the spongy tissue surrounding the labyrinth, and sometimes enter into the vestibule. Ribes asserts that the aqueduct of the cochlea arises at the base of a small depression situated about the centre of the lower edge of the petrous portion of the temporal bone, ascends obliquely to the lower part of the internal auditory passage, passes under the labyrinth, goes horizontally backward and outward, and terminates not in the internal scala of the cochlea, as is stated, but in the canal of the fenestra rotunda below the membrane which closes its opening. As this passage proceeds towards the tympanum it gives rise to numerous branches. It lodges the vessels which are distributed under the labyrinth in the spongy tissue of the petrous portion of the temporal bone and within the tympanum. Thus the two pretended aqueducts belong to the class of vascular canals described in a note on the osseous system. But there are others beside them observed in the petrous process. Ribes mentions three others: 1st, one which arises at about the centre of the posterior base of the petrous process near its upper edge and two lines from the internal auditory passage, goes backward and outward, passes under the anterior semicircular canal, opens directly under the curve of the superior semicircular canal, where it receives the pretended aqueduct of the vestibule, with which it then goes into the spongy substance of the posterior part of the petrous process and in the mastoid cellules, lined by a prolongation of the dura-mater: 2d, another which arises near the centre of the anterior face near the upper edge of the petrous portion, and goes behind the superior semicircular canal: 3d, another which arises at the bottom of the longitudinal fissure which indicates the union of the petrous process with the squamous portion of the temporal bone, and through which pass some vessels which are distributed in the mastoid cells and the membrane of the tympanum. These details may seem minute, but they are of the highest importance, since they contribute to destroy an anatomical error on which rests a part of the theory by which physiologists still explain the philosophy of hearing.

F. T.

II. MEMBRANOUS LABYRINTH.

§ 1945. The *membranous labyrinth** is enclosed in the osseous labyrinth, and corresponds perfectly to its form, although it is much smaller.

It is formed of a thin and whitish membrane, differing entirely from that which covers the inner face of the osseous labyrinth in the early periods of fœtal existence. Its external face adheres to the inner face of the bony labyrinth by a loose cellular tissue. It contains in its cavity a fluid called the *serum* of the *membranous labyrinth* or the *lymph of Cotugno*, (*aquula labyrinthi membranacei*).† Numerous vessels are distributed in its external face.

The upper and posterior part of the osseous vestibule is occupied by a rounded and oblong membranous sac, in which the membranous semicircular canals open, which enlarge also on the parts which correspond to the enlargements of the osseous canals. Before this sac we find one which is rounded, perfectly closed, and consequently entirely separate from the membranous labyrinth, which is smaller, situated partly in the semicircular fossa, and also filled with a serous fluid. These two sacs are attached to the osseous labyrinth by their posterior wall. The anterior, which looks towards the anterior wall of this latter and the fenestra ovalis, is loose and surrounded by the serum of the osseous labyrinth. The semicircular canals are arranged precisely like the osseous semicircular canals.

The membranous cochlea is formed by a fibro-cartilaginous layer, the *membranous spiral lamina*, which is adapted to the external and loose edge of the osseous spiral lamina, and which becoming softer and thinner on the outside, is attached by its external edge to the outer side of the osseous cochlea. This lamina is longer than the osseous, for it extends to the summit of the cochlea. In this part of its course it is loose on its inner edge, while the external is attached as in every other part. It terminates in a prominence.

* Scarpa, *loc. cit.*—Brugnone, *Observations anatomico-physiologiques sur le labyrinthe de l'oreille*; in the *Mémoires de Turin*, 1805-1808, p. 167-176.

† Ribes (*loc. cit.*, p. 207) remarks that there are many adults in whom this humour fills the labyrinth, but there are many in whom it is partially empty, and who nevertheless always hear perfectly. He concludes, from these remarks, that the labyrinth is not constantly filled by serum, and that then there is in fact a space doubtless occupied by an äeriform fluid; but this space, he adds, does not always exist equally in all the cavities of the labyrinth. Sometimes, in fact, we find little of this humour in the semicircular canals, and much in the vestibule and the cochlea; and sometimes the semicircular canals are full, while the other cavities contain but little. Finally he thinks that these changes depend only on the situation in which the cadaver is held. These observations fully confirm those of Brugnone (*Mém. de Truin*, vol. xvi., p. 167), who also thinks that there is almost always serum in all the cavities of the labyrinth, but that this liquid does not exactly fill them in the natural state, because spaces exist in ice removed from them, although liquids acquire more volume by congelation. F. T.

AUDITORY NERVE.

§ 1946. We have already mentioned the origin of the auditory nerve and its course to the internal auditory passage, accompanied by the facial nerve. On entering this canal the auditory nerve divides into several branches, which enter the labyrinth, and the progress of which is indicated by the arrangement of the bones.

In fact, the internal auditory passage* presents at the base of its cavity forward, in the place where the internal and perforated plate of he axis of the cochlea is situated, a crest, the direction of which is rom before backward; it is at first slightly sensible, but is very marked n the adult, which divides it into two halves, a superior and an inerior, which is larger. The first belongs entirely to the facial nerve, while the other belongs to it only in a small portion of its anterior part, o that we may say that the superior groove receives the facial nerve, nd the inferior the auditory nerve. The first is divided by a longituinal prominence into two halves, an anterior, the commencement f the Fallopian canal, and a posterior, in which the superior branch f the auditory nerve is situated.

§ 1947. The auditory nerve is distributed to the membranous byrinth.† Its first branches go to the semicircular canals, and the estibule. The first, the largest, passes through the depression hind the origin of the Fallopian canal, and arrives at the sac of the perior semicircular canal; the second goes to the oval depression the vestibule; the third, still smaller, arrives at the sac of the sterior semicircular canal.

When the first branch has arrived thus far it divides into two twigs, iich separate like a fan; one of them goes to the larger or common c of the semicircular canals, while the other belongs to those of the perior and external canal.

All these twigs are evidently fibrous and interlace on the outer e of the sacs, but when examined on their inner face they appear be a formless mucus. They do not extend over the whole vestibule d the semicircular canals, but remain very distinct upon the surface the sacs.

The nerve then goes forward in the axis of the cochlea, follows ictly the curves of the cavity, and gives off numerous filaments ch go inward through the openings in its axis.

The first filaments given off are the largest; the others gradually inish, and are nearer together.

Finally, the nerve terminates at the summit of the axis by a conrable filament much larger than the others, and which enters the nings in the axis.

* Ribes, *loc. cit.*, p. 660.
† Ribes, ibid, p. 665.

The most internal of these filaments pass through the openings in the curves of the pillar, enter into the canals which terminate there, arrive on the spiral lamina, form an extremely minute plexus along its two faces, and terminate on the membranous spiral lamina, where they are entirely exposed.

Scarpa* asserts that they proceed only between the two plates of the spiral lamina; but they in fact cover also the outside of the superior and inferior faces of this layer,† and those seen in this place, particularly those on the lower face, are even the largest. Some fewer and much smaller filaments pass through the foramina in the spires of the cochlea near the pillar, and go not into the spiral lamina, but to that portion of the membranous cochlea which forms its external wall. All anastomose together on the outside of the cochlea.

The nervous filaments which enter the cochlea are, like the preceding, white, opaque, and evidently fibrous near their origin; but their latter expansions are semitransparent, more grey, and similar to mucus.

§ 1948. The changes which are communicated to the cerebrum by the auditory nerve, and excite there the sensation of sounds, take place in the expansions of this nerve in the membranous labyrinth. These changes are doubtless caused by the compression which the serum in the labyrinth exercises on the ramifications of the nerves, and this pressure is necessarily the consequence of a change in the state of the parts on the outside of the labyrinth, especially in the little bones of the ear and their muscles. In fact, according as the base of the stapes is more or less deeply, and partially or wholly imbedded in the fenestra ovalis, it compresses the serum within it in different degrees, and presses upon different parts of the labyrinth. The external ear and the membrane of the tympanum principally serve to receive the undulations of sound, and to strengthen them, which is effected by the tympanum and the mastoid cells. In regard to the little bones of the ear, independent of the use assigned them, the malleus certainly modifies the degree of tension of the membrane of the tympanum, serving to diminish it in loud and to increase it in weak sounds. The Eustachian tubes serve to evacuate the fluids secreted in the tympanum and to admit the air, to balance that acting on the outside of the membrane of the tympanum. They concur also directly to hearing, for they also lead into the tympanum the undulations of sound, which, reflected by the walls of this cavity, fall principally on the membrane of the fenestra rotunda, called for this reason the *accessory tympanum*.‡

* *De org. aud. et. olf.*, p. 55-56, § xi.

† Monro, *On the ear*, p. 197-199, vol. iii-iv.

‡ Savart has concluded from his important researches on the mechanism of hearing: 1st, that the communication of the vibrations by the air seems to take place, at least for small distances, according to the same laws as those for solid bodies; 2d, that it is not necessary to suppose a special mechanism to cause the membrane of the tympanum to vibrate continually in unison with the bodies which act

ARTICLE THIRD.

DIFFERENCES IN THE EAR DEPENDENT ON DEVELOPMENT.

I. EXTERNAL EAR.

§ 1949. The external part of the organ of hearing does not begin o appear till towards the end of the second month of pregnancy. [t first resembles a slightly perceptible eminence formed like an longated triangle, the base of which looks upward, the summit downvard, and which is directly continuous with the lower part of the side f the head, and in the middle of which is a triangular longitudinal issure which becomes narrower and deeper from above downward. The prominence which surrounds the median depression soon rises to ts posterior part, and becomes thinner in this place. It projects bove the surface of the side of the head, and slightly shows the edian fossa. At the same time, or soon after, the anterior part of e prominence is divided by a transverse fissure which arises from s posterior part into two halves, of which the inferior is the antiagus and the superior the commencement of the helix. At the same me this anterior part of the external ear also rises and the posterior

on it, and that it is always in the conditions fit to be influenced by any number vibrations; 3d, that its tension probably does not vary, except to increase or ninish the extent of these variations, as Bichat had asserted, but always supposing, Meckel still admits, the contrary of what results from these experiments, that is, imagining that the membrane is loose in loud and tense in feeble sounds; 4th, at the vibrations of the membrane extend to the labyrinth unchanged by means the little bones; 5th, that the little bones also serve to modify the extent the vibrations of the parts in the labyrinth; 6th, finally, that the tympanum proibly serves to contain an air the physical properties of which are constant. Itard serts that the membrane of the tympanum does not perform any motion which visible or denoted by a bristle situated in the centre; but the more delicate periments of Savart do not allow us to doubt these motions. When we saw the mporal bone on the level of the external face of the membrane, and cover this with nd, we can perceive that the grains move slightly when we bring a disque which vibrating, parallel to the membrane and near the surface, although its slight exnt and especially its form do not allow us to establish there any nodal line. Itard ates that the function of the little bones are to allow us to hear low tones. J. F. St. ilaire thinks that they are of but little use, and are only indications of the respirary apparatus, the operculum developed in fishes. The justice of this second prosition, which we shall not examine here, would not necessarily involve that of the st, although not contradicted by experience. The direct participation of the istachian tube in hearing, which was asserted in the commencement of the last ntury, and afterwards brought forward by Bressa, is evidently erroneous. It has en perfectly refuted by Cotugno and Itard. If it was correct, we ought, as Rulphi asserts, hear our own voice when speaking loudly after stopping the ears: t this is not true. Itard has very ingeniously compared the Eustachian tube to a le without which the air in a military drum would not vibrate; but he is mistaken saying that it seems only to renew the air in the tympanum. This is undoubtedly principal function, but it also serves to excrete the mucus and the condensed spiration constantly secreted by the mucous membrane of this cavity. F. T.

enlarges, but is not removed farther from the side of the head. The anthelix and the tragus are developed also very early at the third month. The anthelix is at first more prominent than it is subsequently, because the posterior edge of the ear rises but slightly or not at all. The lobule appears last.

The external ear is much smaller in proportion to the head, the younger the fœtus is.

Its cartilage begins to appear at the third month; but it is developed slowly, for towards the end of pregnancy it is not as yet so extensive under the skin as in full grown individuals.

The cartilaginous portion of the auditory passage, like the external ear, is at first proportionally much smaller than subsequently.

The long portion of this passage begins to form some time after birth by the enlargement of the cavity of the tympanum. Its ossification is singular in this respect, that it generally begins much sooner in the external part of the canal, where it unites to the cartilaginous portion, than in the middle region of its lower part.

The prolongation of the external cutaneous system, around which this passage is situated, already exists very early in the fœtus, and it is not then even proportionally much shorter than in the adult, but it has another form and another direction. As the direction of the tympanum is then much more oblique from without inward than it is afterward, the upper part of its circumference at first does not exist; the inferior alone is developed, and forms on the outside and at the bottom of the tympanum, a large sac, which is much more ample in proportion to its length than it is afterward, descends also more perpendicularly, and is situated below the membrane of the tympanum, so as really to form its upper wall.

The skin of the bony portion of the auditory passage is softer and thicker in the fœtus than in the adult.

II. INTERNAL EAR.

§ 1950. 1st. The tympanum in the early periods of life is proportionally shorter and narrower than at a later season, particularly, because the mastoid process is very small, and its cells are not yet formed. It is filled in the fœtus with a thick gelatinous fluid, and it communicates with the mouth more directly the younger the fœtus is, since the Eustachian tube is shorter and broader in the same proportion. The cartilaginous portion of this tube, until the middle of pregnancy, is simply membranous, and even in the full grown fœtus the bony portion is at most separated within the canal by a layer of bone, which formation continues most generally through life, so that the septum rarely extends also to the outer side.

The tympanum, and with it the membrane, are much larger in proportion either to the external ear or to the whole head and body, the younger the fœtus is, and even until in the fifth month of pregnancy,

both are larger than the external ear. Besides, as the osseous portion of the auditory passage is not yet developed, the membrane of the tympanum is much nearer the surface in the early periods of existence than subsequently, so that the upper part directly touches the entrance of the cartilaginous portion of the auditory passage, and consequently is almost exposed in this point, a very curious circumstance from its analogy with reptiles. Both also differ at first in direction, which is more horizontal. because at this period the membrane of the tympanum is more oblique from above downward and from without inward.

2d. The small bones of the ear differ from all other bones of the body by their uncommonly early appearance and development.

They are visible and even uncommonly large in proportion, at the commencement of the third month of pregnancy, although at this period they are still entirely cartilaginous, and we cannot well distinguish the stapes from the incus. Thus, for instance, the malleus is about three lines high in the fœtus of four months, so that the body being then four inches from the vertex to the coccyx, its length is to that of the whole body as 1 : 16, while in the adult, where it is four lines long, and where the distance between the vertex and the coccyx is two feet and a half, the proportion is only as 1 : 90. The small bones of the ear are as large in the full grown fœtus as in the adult.

They begin to ossify also very early, even before the end of the third month. Cassebohm asserts* that the stapes and incus ossify sooner than the malleus, that the osseous nucleus of the incus is seen first in its anterior branch, and that of the stapes in the head, whence it extends along the two branches to the base, which, with the lower region of the anterior branch, ossifies the last. In the malleus, ossification commences in the head and anterior process. Our observations do not exactly agree with those of Cassebohm. It is true that the anterior branch of the incus ossifies before the posterior: we have always found it perfectly ossified, while the latter was entirely cartilaginous, but the ossification of the malleus commences at the same time as that of the incus, and the stapes is still entirely cartilaginous, when it has advanced considerably in the other two bones. The place where it begins in the stapes is not well determined: it is sometimes in the lower part of the posterior branch, and sometimes in the base, but never, according to our observations, in the head.

These bones differ very much in their forms. The incus changes the least. The branches of the stapes seem at first not to be separated from each other, which deserves to be noticed on account of the analogy resulting from it with the formation of this bone in the cetaceous animals, and with that of the inner part of the single bone of the ear in birds and reptiles. It is certain that even where these two branches are detached from each other, the opening between them and the base is proportionally much smaller than at subsequent

* *Loc. cit.*, p. 56.

periods, although, however, its form is then less oblong. This narrowness of the foramen, which is evidently an approximation to its entire deficiency, and the union of all the parts of the stapes in one, depend principally on the greater thickness of its branches.

But of all the bones of the ear, the malleus changes the most during its development. Perhaps no other bone can be compared with it in this respect.

The most remarkable difference is the existence of a right cartilaginous process, formed like a very elongated cone, which is also very long and very thick in proportion to the rest of the bone. This process arises from the anterior side of its head, leaves the tympanum between the petrous process of the temporal bone and the ring of the tympanum, is fitted directly to the inner face of the lower jaw, and extends to the anterior extremity of this bone, where it sometimes, perhaps even always, unites with that of the opposite side. This cartilage never ossifies, although in the commencement it forms most of the mass of the bone; it disappears at the eighth month. The anterior process of the malleus corresponds with it, it is true, to a certain extent, in respect to its position: but we also perceive that in the fœtus, where the two parts are distinct rom each other, the cartilage is situated above the anterior process. We may then at most admit that this latter makes part of it, and that they are separated very early. This cartilage is very curious, because fishes, reptiles, and birds, present a similar one, which extends from the posterior to the anterior portion of the lower jaw. In these animals it rests on a small bone placed on the inner face of the posterior part of the lower maxillary bone, and we may consider it as a rudiment of the malleus, which does not exist in them.

3d. The membranous labyrinth exists long before the osseous labyrinth. We have found it at three months perfectly developed in the cartilaginous mass, which afterwards ossifies. Even in the early periods of life it is more distinct, and formed of firmer and more solid membranes than at subsequent periods. It is composed at first of two very distinct membranes, an external and an internal, which are simply enclosed in each other, but there is no continuity between them.

The internal is white, transparent, thinner, but firmer and more elastic than the external. The latter does not adhere to the cartilage, as afterward it is not attached to the bone, which is developed at the expense of this latter.

The inner face of the external membrane is smooth, and the external is corrugated. It gradually disappears, so that at seven months we cannot trace it. Before entirely disappearing it gradually becomes thinner. The internal becomes proportionally narrower but firmer: it seems to be attached more intimately to the inner face of the cartilage which surrounds it, in the early periods of existence, than subsequently.

As yet we have been unable to ascertain if there is not a period when the membranous labyrinth is uncovered in the skull, at least in part, and where its structure is more simple than it is afterward. At three months it is entirely surrounded by a mass of cartilage, and is as complex in its structure as at a more advanced period of life. We only remark, that like the cartilage which envelops it, it is at first more compressed from without inward, and proportionally higher, which undoubtedly depends, at least in part, on the greater development of the encephalon.

At four months we find the membranous cochlea as complex as it is in the adult, while afterward its circumference seems to be formed only by the membranous labyrinth; it is then constituted by a very thick membrane, which makes a part of this latter. We have as yet been unable to obtain any sufficient data in regard to its form before the fourth month of pregnancy.

The secondary tympanum and the fenestra rotunda are at first situated more externally and parallel to the membrane of the tympanum. They afterwards go backward, which depends principally on the development of bone in their circumference.

4th. When we study the development of the osseous labyrinth, we must distinguish the formation of the osseous substance of the petrous process of the temporal bone from that of its own. The first commences before the second, and follows the usual mode of ossification, that is, it takes place by the development of a loose, soft, and plexiform tissue in the homogenous mass of cartilage previously existing, which gradually extends from before backward. The circumference of the fenestra rotunda ossifies first towards the end of the third month, which is curious as an analogy between this opening and the tympanum. Ossification begins at the upper part, then extends to the lower, and when it has thus formed a ring, it goes forward. At the same time there is developed a special osseous nucleus, which is entirely distinct from the preceding, at the outer extremity of the superior perpendicular semicanal: next there appears a third small scale at about the centre of the internal perpendicular semicanal. At the same time ossification proceeds rapidly backward and downward from the point first formed, and gives rise to the floor of the labyrinth. The second nucleus enlarges more quickly perhaps than the first, so that the superior perpendicular semicanal is soon entirely ossified, excepting only its lower and concave face. At the same time, ossification commencing at its internal extremity, advances on the internal face of the petrous process, circumscribes the internal auditory foramen, enters within it, and forms the floor of the cochlea.

The horizontal semicircular canal begins to ossify at the fifth month. At this time the piece of bone which forms the superior perpendicular canal extends backward, downward, and outward around the membranous horizontal canal. At least we have been unable to discover a special nucleus for this canal, which seems to ossify by the extension of the first two nuclei, the edges of which finally unite.

The formation of the interior of the cochlea belongs almost wholly to the osseous labyrinth. The cartilage and then the osseous substance of the petrous process, do not participate in it except by a narrow prolongation sent by this latter into the cavity containing the membranous and then the osseous labyrinth, the spires of which it slightly separates.

The loose edge of this projecting lamina is turned outward. It extends from the upper part of the fenestra rotunda and the outside of the cochlea, to the summit of this latter, across its cavities, and thus divides it anteriorly, but very imperfectly, into an external and an internal cavity. This lamina is broader at first than it is subsequently. Besides, the internal face of the cochlea is entirely smooth, and this part of the internal ear presents at this period the greatest analogy with the cochlea of birds: at a later period, after the third month, as the cochlea enlarges from without inward, the lamina in question becomes narrower, and at the same time slight prominences are developed, which separate externally the two and half turns of the cochlea from each other, and make part of it.

The osseous labyrinth is at first entirely separated from the osseous mass of the petrous process which surrounds it, and which is developed before it. It is, however, always applied to it. Its surface then is entirely smooth. The inner face of the osseous mass of the petrous process is also smooth to a certain extent, although more corrugated than that of the labyrinth. The two surfaces soon blend together, but they can be entirely separated in children, and the smooth polished surface of the labyrinth can be demonstrated; but they afterward become inseparable. The line of demarcation is very evident in every part, particularly in the cochlea, where it is perceived that the prolongations described above are perfectly distinct from the canal formed by the membranous and osseous labyrinths.

Thus the osseous labyrinth is developed independent of the osseous substance of the petrous portion. As the external membrane of the membranous labyrinth disappears at the period of its formation, it is not improbable that it changes into osseous substance, or at least that this substance transudes through its external face. In fact, this membrane does not exist for some time with the osseous labyrinth, and may always be easily separated from it: but we are satisfied, from numerous observations, that as the osseous labyrinth is developed around it, it becomes denser, firmer, dryer, and in a measure horny: hence we have been induced to believe that the two modes of formation co-exist, that is, that the membrane secretes first the labyrinth, then that an analogous substance being deposited with it, it unites with the layer it had first formed, and becomes its internal layer. The formation of the osseous labyrinth would thus resemble that of the teeth.*

* Ribes has asserted that in the fœtus the serum of the labyrinth is reddish, bloody, and exactly fills it. As the infant grows older, it becomes clear, limpid, and less in quantity, and the ear becomes more sensible to sounds. F. T.

ARTICLE FOURTH.

ORGAN OF HEARING IN THE ABNORMAL STATE.

§ 1951. As the organ of hearing is very complex, it presents very numerous and very different anomalies* in respect to their essence; by these the ear is unusually hard or soft, or is entirely deficient.

§ 1952. The *deviations of formation* are here, as in every other part, the most interesting in a physiological point of view.

As in all other parts of the body, they are more or less characterized by a retarded development,† and are also more or less repetitions of what is observed in animals inferior to man.

Sometimes the development of the whole ear is arrested.‡

I. EXTERNAL EAR.

§ 1953. 1st. *Deviations of form in regard to quantity.* The *entire absence* of the external ear, of which we possess some instances, depends on the permanence of a state which marks the early periods of fœtal existence.

The anomaly varies a little less from perfect development when the ear is closed, which can exist in different degrees; these lead imperceptibly to the normal formation by the shortness and narrowness of the external auditory passage.

The absence of the lobule, or its adhesion with the skin of the head, the least deviation from the normal state. This state also exists regularly at a certain period of the formation of the fœtus.

We may consider the frequent enormous enlargement of the ears an anomaly of an entirely different character.

2nd. *Deviations of formation in regard to quality.* These are the turning of the ear on the orifice of the external auditory passage, which more or less closes this canal.§

II. INTERNAL EAR.

A. TYMPANUM.

§ 1954. 1st. *Deviations of formation in respect to quantity.* Sometimes the tympanum is not sufficiently large, and is even closed on the

* Besides the works of Duvernoy, Wildberg, and Saunders, already mentioned, which treat also of the diseases of the ear, consult, J. A. Rivinus, *De auditus vitiis*, Leipsic, 1717.—J. M. G. Itard, *Traité des maladies de l'oreille et de l'audition*, Paris, 1821.—C. F. A. Eschke, *Diss. de auditus vitiis*, Berlin, 1819.

† See on this subject our *Handbuch der pathologischen Anatomie*, vol. i. pp. 9—466.

‡ Rœderer, *Descript. fœtus parasit.*; in *Comm. soc. Gœtt.*, vol. iv.

§ Walter, *Fetthautgeschwülste*, Landshut, 1814, p. 33.

outside as in fishes. Sometimes one or more of the little bones of the ear are deficient, or they are too small.* Sometimes they are unusually large, thus preserving the distinctive characters of the fœtus. They are rarely more numerous than usual. When supernumerary bones exist, they are always very small. They occur particularly between the malleus and incus, and also in the neck of the stapes.

2nd. *Deviations of formation in regard to quality.* The bones of the ear are sometimes formed after a different type, and then are more or less similar to those of certain animals.

Thus Comparetti† observed in a man, that not only the two stapedes were very small, but also formed by a single branch, with a small base closing the fenestra ovalis, which was very narrow.‡

B. LABYRINTH.

When the labyrinth is very imperfectly developed, there is only a single cavity closed externally, which is not divided into the vestibule, cochlea, and semicircular canals, and which does not communicate with the tympanum.§ This form resembles that of the organ of hearing in the crustacea and the cephalopoda. Perhaps it is normal also in the early periods of the existence of the human fœtus.

When the development is more advanced, the cochlea describes fewer turns than usual,|| even as in reptiles and birds, it appears as a sac-like prolongation, which is not curved on itself. From our preceding remarks, this anomaly should be considered as a continuance in the fœtal state.

The labyrinth is sometimes ossified imperfectly, whence a portion of the membranous labyrinth is exposed.¶

* Bernard, *Sur un vice d'organisation de l'oreille externe*; in the *Journ. de physiol. expér.*, vol. iv. p. 167.

† *Loc. cit.*, p. 24.

‡ We find the malleus sometimes larger, sometimes shorter, sometimes with an enlarged head or process. The incus has been observed sometimes narrower, sometimes broader, and sometimes with its long branch more or less arched. Rudolphi has described and figured (*Diss. sis. observationes osteologicas*, Berlin, 1812, tab. i. fig. 15.) a stapes, of which the branch alone communicated with the base, the other being loose, and forming with the preceding an obtuse angle. Lœsecke seems to have observed a similar case (*Obs. anat. chirurg.*, Berlin, 1754, p. 15.) Tiedemann has described a stapes found in a newly born infant, which presented neither branches nor opening. It resembled a small pyramid, the base of which represented the plane surface, and from whence a piece of bone arose, slightly depressed, which was articulated with the long branch of the incus by a rounded process. He has also seen in an adult the two branches of the stapes completely united by a layer of bone, so that there is a slight depresssion, but no opening between them (*Sur quelques variations dans la forme de l'etrier chez l'homme*; in the *Journ. complém. des. sc. méd.*, vol. viii. p. 83. F. T.

§ Roderer, *loc. cit.*—Meckel, *Handbuch der pathologischen Anatomie.* vol. i. p. 406.

|| Mondini, *Anat. surdi nati*; in the *Comm. Bonon.*, vol. viii.—Meckel, *loc. cit.* vol. i, p. 403.

¶ Mondini, *loc. cit.*

C. AUDITORY NERVE.

Sometimes in deaf and dumb people the auditory nerve is smaller* by half than it is generally.†

§ 1955. The *accidental* or *consecutive deviations of formation* result from an external lesion, which is purely mechanical, or an alteration in texture. Sometimes in hydrocephalus the two external bones of the ear are pushed outward and detached from the stapes, and sometimes even this is unconnected with the fenestra ovalis.‡

§ 1956. The *alterations of texture* in the organ of hearing are principally *inflammation* and its consequences, among which we must first mention *adhesion* and *suppuration*, which frequently affect the external and the internal ear. The buccal orifice of the Eustachian tube is frequently obliterated after scarlatina, or the tympanum and the bones are destroyed by ulceration. The entire or partial destruction of the membrane of the tympanum and very probably also the anomalies in the tumors of the labyrinth, which are thickened,§ solidified, and changed into a hard body‖ after long affections of the internal ear,¶ belong to this class.

The new formations developed in the organ of hearing:

1st. *Accidental ossification*, by which the bones of the ear adhere to each other, and obstruct the fenestra rotunda,** in which case we also find the bones, particularly the stapes, twice as large as they are generally: the stapes also is fused with the fenestra ovalis,†† and forms osseous concretions‡‡ in the membrane of the tympanum.§§

* Haighton, *Mem. of the med. society*, vol. iii. p. 1.

† This fact has been observed several times, among others by Sylvius, Hoffman, and Arenda. Itard also has seen it: but he thinks that the wasting of the auditory nerve is more frequently the effect than the cause of deafness (*loc. cit*, vol. i. p. 392.) F. T.

‡ Blumenbach, *Geschichte der Knochen*, p, 140.

§ Haighton, *loc. cit.*—Cline, in Saunders, *loc. cit.*, p. 88.

‖ See on this subject an important memoir on the physiological relations, by G. F. St. Hilaire, *Sur la nature, la formation et les usages des pierres qu'on trouve dans les cellules auditives des poissons*; in the *Mém. du Muséum*, 1824.

¶ Itard has seen one case (*loc. cit.*, vol. i, p. 395) where the fluid of the labyrinth was deficient.

** Cotugno, *loc. cit.*, § 72, p. 61.

†† Valsalva, *De aure humanâ*, cap. ii. § x.

‡‡ Cassebohm, vol. iii., p. 33.—Lœsecke, *Obs. anat.*, p. 25.—Kœhler, *Beschreibung der Loderischen Präparate*, p. 148.

§§ Ribes, (*loc. cit.*, p. 654,) has found the membrane of the fenestra rotunda ossified in a man completely deaf, and destroyed in several subjects, some of whom had not completely lost the power of hearing. This latter circumstance deserves to be remarked, since complete deafness does not result from injuries of the membrane of the tympanum, which is so analogous to that of the fenestra rotunda. According to Pinel's observations, it would seem that deafness depends on an alteration in the texture of the mucous membrane of the internal ear rather than on any other cause, although he seems to attribute it to the diminution of the fluid in the labyrinth, which in this case is only a consequence of inflammation. (*Recherches sur les causes de la surdité chez les viellards*; in the *Archiv. gén. de méd.*, vol. vi., p. 247). F. T.

2d. The formation of accidental cartilages and fibro-cartilages sometimes observed under the form of tumours which adhere to the auditory nerve.*

Among the entirely abnormal formations we must arrange the *fungous* tumours and the *polypi*, which are developed principally in the mucous membrane of the auditory passage.

CHAPTER II.

ORGAN OF SIGHT.

§ 1957. The *organ of sight* (*oculus*)† occupies the upper part of the front of the face, and is situated on the right and left, on the sides and above the root of the nose in the orbit and circumference of this cavity. We distinguish the *eye* or the *globe of the eye* (*bulbus oculi*) with the muscles which move it and the parts which protect it.

ARTICLE FIRST.

PARTS WHICH PROTECT THE EYE.

§ 1958. The parts which protect the eye,‡ comprise two folds of skin, called the *eyelids*, very thick hairs, called the *eyebrows*, and the *lachrymal passages*.

* Sandifort, *Obs. anat. pathol.*, book i. c. 9.

† Fabricius d'Aquapendente, *De visione, voce et auditu*, Venice, 1606.—V. F. Plemp, *Ophthalmographia, s. tractatio de oculo*, Louvain, 1648.—G. Briggs, *Ophthalmographia, seu oculi ejusque partium descriptio anatomica*, London, 1685.—J. Taylor, *Nouveau traité d'anatomie du globe de l'œil, avec l'usage de ses différentes parties, et de celles qui lui sont contigués*, Paris, 1738.—A. Bertrandi, *Diss. II. de hepate et oculo*, Turin, 1748.—J. G. Zinn, *Descriptio anatomica oculi humani*, Gottingen, 1753.—G. Porterfield, *Treatise on the eyes, the manner and phenomena of vision*, Edinburgh 1759.—M. Horrebow, *De oculo humano ejusque morbis*, Copenhagen, 1792.—A. Monro, *Miscellaneous observations on the structure and the functions of the eyes*; in his *Treatise on the brain, the eye, and the ear*, Edinburgh, 1797.—S. T. Sœmmerring, in Demours, *Traité des maladies des yeux*, vol. iv.—J. G. G. Voit, *Oculi humani anatomia et pathologia*, Nuremberg, 1810.—C. H. T Schreger, *Versuch einer vergleichenden Anatomie des Auges*, Leipsic, 1818.—D. G. Sœmmerring, *De oculorum humani animaliumque sectione horizontali*, Gottingen, 1818.—J. A. Hegar, *Diss. de oculi partibus quibusdam*, Gottingen, 1818.—C. F. Simonson, *Anatomico-physiologicus tractatus de oculo*, Copenhagen, 1820.

‡ Rosenmuller, *Organorum lacrymalium partiumque oculi externarum descriptio*, Leipsic, 1797.

I. EYELIDS.

§ 1959. The *eyelids* (*palpebræ*) are perpendicular folds situated ·fore the anterior orifice of the orbit, which they close more or less ·rfectly. They are distinguished into *upper* and *lower*. They end together in the *great* or *internal* angle, and the *small* or *exter-*·*al angle* of the eye (*canthi oculi, internus et externus*), and are se-·rated from each other their entire breadth by a *transverse fissure* (*fissura palpebrarum*).

The superior is much greater than the inferior; a flat ligament ·rmed of transverse fibres several lines long, leaves the great angle the eye and goes inward between the fibres of the internal portion the orbicularis palpebrarum muscle; its internal extremity is ·oader than the external, and is attached to the upper part of the ·sal process of the superior maxillary bone. This is the *palpebral* ·*gament* (*lig. palpebrarum*).

The *eyelids* are composed of two layers of skin, one external and ·e other internal, of cartilage and muscular fibres. They rarely or ·ver contain fat.

The exterior layer of skin makes a part of the external cutaneous ·tem. It differs from the rest of the skin only in being very thin ·d destitute of hair.

It is continuous on the edge of the eyelids, which is nearly a line ·oad, with the internal layer which belongs to the internal cutane-·s system, that is to the mucous membranes. This layer is also ·n, reddish, and moist.

·t is termed the *conjunctiva*. It lines the whole extent of the inner ·e of the eyelids, is reflected on itself in the parts where these move-·le folds are attached to the rest of the skin, and is called the ·*ica adnata*, is fitted to the anterior part of the *sclerotica*, from ·ich it may always be easily separated, and which it covers to the ·rumference of the transparent cornea. At least it is not possible ·ctly to demonstrate that it extends also on the anterior face of · last membrane, for if in certain morbid affections a layer rises the anterior face of the cornea, this circumstance authorizes us to ·ık, but does not prove, that this layer in question is a prolonga-· of the conjunctiva. Admitting that this passes really on the ·nea, and that it blends with the external pellicle of this mem-·ne without any marks of separation, it does not follow that it ·sesses in this place the characters of a serous membrane,* for anterior face of the transparent cornea belongs rather to the · of the mucous membranes.† Walther has already demonstrated‡

·. F. Walther, *Abhandlungen aus dem Gebiete der praktischen Med.*, Land-·, 1810, p. 113.
·Wardrop, *Morbid Anatomy of the eye*, Edinburgh, 1818, p. 14.
·*Loc. cit.*, p. 111.

that it is wrong to exclude the conjunctiva entirely from among the last membranes. The adhesions * between its two opposite faces which have been brought forward to separate it from the other mucous membranes, and which have been used to a certain extent to class it among the serous membranes, are rare and accidental, and supervene probably after suppuration, in which case even the mucous membranes contract adhesions.

A. EYELASHES.

§ 1960. The anterior part of the edges of the eyelids presents three or four irregular ranges of short, straight and arched hairs, which gradually become larger from the two angles of the eye to the centre, and which are termed the *eyelashes* (*cilia*)† Those of the upper lid are more numerous and stronger than those of the lower. The former are arched from above downward, and the latter from below upward. When the lids close they intercross and form from their curve a broad ridge.

B. MEIBOMIAN GLANDS.

§ 1961. Farther back and nearer the posterior limit of the edge of the eyelids, at about its centre, is a series of openings regularly arranged which are also larger in the upper than in the lower eyelid, and which do not occupy the entire breadth of these moveable lids. These openings lead to the *glands of Meibomius*, or the *sebaceous glands of the eyelids* (*Gl. Meibomianæ*, s. *palpebrarum sebaceæ*), small, very elongated, narrow, tortuous bursæ, which terminate in sacs generally single, but sometimes divided at their base into several compartments, which are situated perpendicularly below the conjunctiva, between it and the tarsal cartilages. These glands are filled with a thick, yellowish viscous substance, called *lema*, which accumulates around the eyelashes during sleep, and which is easily distinguished by its colour from the red conjunctiva.

C. PALPEBRAL CARTILAGES.

§ 1962. Each eyelid contains between the two layers of skin and near its loose edge an oblong cartilage called the *tarsus*, which determines its form. These cartilages extend much farther from without inward than from above downward, and they are very thin from before backward. They are much thicker at their loose and straight edge than on their convex portion, which looks to the base of the

* A. Schmidt, in the *Ophthalmologische Bibliothek.*, vol. iii., part 1. p. 18.
† H. Meibom, *De vasis palpebrarum novis Epist.*, Helmstadt, 1666.

eyelids; they extend on the inside only to the lachrymal puncta, and terminate on the outside also a little before the commissure of the two eyelids. Their convex edge and their internal and external extremity becomes at the two angles of the eye a very dense cellular tissue, which is called the *tarsal ligament* (*lig. tarsi, internum et externum*); this unites them to the external and internal edge of the anterior opening of the orbit.

D. MUSCLES OF THE EYELIDS.

§ 1963. The eyelids have two muscles, which act in opposite directions, the *orbicularis palpebrarum* and the *levator palpebræ superioris* muscles. The first is common to the two; the second belongs to the upper eyelid only. The lower eyelid has no special muscle.

A. ORBICULARIS PALPEBRARUM MUSCLE.

§ 1964. The *orbicularis palpebrarum* muscle, *naso-palpébral*, Ch. *M. sphincter palpebrarum*, s. *oculi*), is thin, membranous and circular, although a little elongated. It occupies the upper and anterior part of the face and the lower and anterior part of the skull. Consequently it is not by any means confined solely in the eyelids.

Its internal part is the slightest but the thickest. After leaving this point it extends considerably upward, downward and outward.

It is attached above and below to the palpebral ligament, so that it may be said to leave the inner angle of the eye and to return to it.

Besides this origin, several other fasciculi pass before and behind the palpebral ligament, whence it follows that a portion of this muscle is formed by uninterrupted circular fibres.

The orbicularis muscle arises above by short tendinous fibres from the upper extremity of the nasal process of the superior maxillary bone, from the os unguis, and the lower and anterior part of the nasal and orbitar portions of the frontal bone.

It arises below by similar fibres from the lower part of the inner edge, and from the inner part of the lower edge of the orbit, which are formed by the ascending process and by the body of the superior maxillary bone.

Its fibres separate especially in its lower part, and fasciculi are detached from its outer part, some of which go to the cellular substance and others enter the zygomaticus minor and the levator labii superioris muscles.

The internal part of this muscle which is contained in the eyelids, where it is situated directly below the external cutaneous layer, is much less extensive than the external. Its fibres are straighter, thinner and paler than those of the latter, with which it is always

uninterruptedly continuous, although it has been considered a special muscle, called the *ciliaris* muscle.

B. LEVATOR PALPEBRÆ SUPERIORIS MUSCLE.

§ 1965. The *levator palpebræ superioris* muscle, *orbito-palpébral*, Ch., is very long, thin, and triangular. It arises by a short tendon at the base of the orbit from the periosteum which lines the upper part of the optic foramen, and blends in this place with the tendons of the rectus internus and rectus superior muscles. It gradually becomes broader and thinner, advances directly under the orbitar plate, covering first the inner and then the whole of the rectus superior muscle. It finally becomes a very thin tendinous expansion, often scarcely perceptible, part of which is attached to the upper edge of the superior palpebral cartilage, while the other passes between the orbicularis palpebrarum muscle and this cartilage, and extends to its lower edge where it is inserted.

It raises the upper eyelid.

E. THIRD EYELID AND CARUNCULA LACHRYMALIS.

§ 1966. Beside the upper and lower eyelids there is also in the great angle of the eye a third, which is much smaller and imperfect.

The two palpebral commissures differ in form. The external is more pointed than the internal. The latter resembles a small and narrow prolongation of the palpebral fissure towards the nose, the separation of which with the rest of the fissure is marked very evidently by the lachrymal puncta, and which terminates inward in a rounded edge.

The third eyelid is found in this space.

It has the form of a triangle, the summit of which looks inward and the loose edge outward; this last is semicircular. It is formed by a fold of the conjunctiva by a small palpebral cartilage situated near its loose edge, and by a considerable number of sebaceous glands united in a rounded or slightly triangular mass, between which are small, straight and very fine hairs analogous to the eyelashes.

The sebaceous glands are situated entirely inward, and project particularly on its anterior face.

They are called the *caruncula lachrymalis.* The external and loose part of the third eyelid, which passes much farther forward than the caruncula, has been termed the *semilunar fold* (*plica semi-lunaris*).

This part then really possesses all the constituent parts of an eyelid. It differs from the other eyelids by its smallness and in the deficiency of an external layer of skin and of muscular fibres. It is in fact a rudiment of the third eyelid which exists in most vertebrated animals. In fact the perpendicular eyelid of these last differs from it only by its

;eater size. When we descend in the animal scale we see that its ›velopment is always in an inverse ratio with that of the horizontal ,elids, and that finally it entirely replaces them.

II. EYEBROWS.

§ 1967. The *eyebrows* (*supercilia*) are short, strong compact hairs, hich gradually increase in size from within outward, and which are ·ranged in several superimposed striæ. These hairs form a little ›ove the upper eyelid an arch, the convexity of which looks upward. he two arches they describe blend more or less at the inner part.

We may consider this part of the face as the commencement of e upper eyelid.

The eyebrows are moved each by a special muscle, the *corrugator percilii.*

The *corrugator supercilii* muscle (*fronto sourcilier*, Ch.) is thick ıd large. It covers the inner part of the upper edge of the orbit. is covered at its origin by the upper internal part of the orbicularis .lpebrarum muscle, and by the internal and inferior part of the ›ntalis muscle; it arises by very short tendinous fibres from the frontal ·ne, below the inner part of the supraciliary ridge. Its fibres are ›lique. Its direction is outward, and it gradually becomes thinner. is so blended, particularly in its external part, with the upper rtion of the orbicularis palpebrarum muscle, which entirely covers and which may be considered as a deep layer of this latter muscle. It wrinkles the eyebrows, and the skin of the forehead perpendilarly.

III. LACHRYMAL PASSAGES.

§ 1968. The *lachrymal organs* or *passages* (*organa lachrymalia*, s. *æ lachrymales*), form a special apparatus, the function of which is to crete and excrete a transparent liquid termed the *tears* (*lachrymæ*).*

This apparatus includes the *lachrymal gland* and its excretory ducts, e *lachrymal puncta*, and the *lachrymal passages*, the *lachrymal sac*, ıd the *nasal canal*. We may annex to a certain extent the connctiva, as it is uninterruptedly continuous with the excretory pasges, the gland, and the lachrymal puncta, and as, strictly speakg, it is only a considerable dilatation of the excretory portion of the :hrymal organ.

A. LACHRYMAL GLAND.

§ 1969. Only one *lachrymal gland* is commonly admitted:† there ·, however, two, generally arranged so that one is superior, the other

* Berzelius, *Djurkemi*, vol. ii. p. 219-221.

† N. Stenon, *De glandulis oculorum novisque eorum vasis observationes anaicæ quibus veri lacrymarum fontes deteguntur*; in the *Obs. anat.*, Leyden, 1662.

inferior. Both belong to the list of conglomerate glands. They are situated behind the upper eyelid, directly below the orbitar plate.

The *superior lachrymal gland* (*Gl. lachrymalis superior*, s. *innominata Galeni*), is much larger than the other. It occupies the lachrymal depression of the frontal bone. It is triangular, and flattened from above downward. The *inferior* (*Gl. congregatæ Monroi*)* touches at its posterior extremity the anterior part of the preceding, and extends to the external part of the upper edge of the cartilage of the upper eyelid. Its lobules are smaller and more remote from each other than those of the upper.

Six or seven very small canals arise from these two glands and go from behind forward, from without inward, and from above downward, and open at the side of each other from without inward, on the inner face of the upper eyelid, near the external angle of the eye.

B. LACHRYMAL PUNCTA AND LACHRYMAL PASSAGES.

§ 1970. The upper and the lower eyelids present each, at the part where the inner angle commences, and where the orifices of the Meibomian glands terminate, an opening, the direction of which is rather more backward, and which may easily be distinguished from those of the palpebral glands and the lids, as its diameter is much larger, and as it is supported by a conical prominence. These two openings are termed the *lachrymal puncta* (*P. l. superius et inferius*). The direction of the upper is downward, and that of the lower is upward. The latter is most generally larger than the other.

These puncta are the orifices of the *lachrymal passages* (*canaliculi lachrymales*, s. *coruna limacum*), which extend to the lachrymal sac.

The lachrymal passages proceed directly on the edges of the eyelids, covered posteriorly by the internal cutaneous layer of these lids, and anteriorly by the orbicularis muscle, with which they are so intimately connected, that they are detached from its fibres with great difficulty.

The superior first ascends a little outward, in which direction also the inferior descends. In this part of their course they are very narrow. Then after slightly projecting, the superior goes inward and downward, and the inferior upward, and both converge very much. Arrived at the inner angle of the eye, they pass under the palpebral ligament, and open into the anterior and external part of the lachrymal sac, one directly above the other, but by two distinct orifices. They form within this cavity a small rounded prominence.

A whitish and smooth mucous membrane forms their parietes.

A. Monro, *On the lachrymal glands and ducts*: in the *Anatomical and physiological observations*, Edinburgh, 1738, p. 770. tab. ii.—J. J. Beaux, *Physiologie de la glande lachrymale*, Paris, 1821.

* *Loc. cit.*, p. 77.

C. LACHRYMAL SAC.

§ 1971. The *lachrymal sac* (*saccus lachrymalis*) differs much in its breadth, direction, and structure, from the lachrymal passages.

It is infinitely broader than they, but it contracts a little from above downward.

It is covered anteriorly by the inner part of the orbicularis palpebrarum muscle, and is situated above in the lachrymal groove, along which it extends upward into the lachrymal passage by a small cul-de-sac, and downward into the *nasal canal.* It descends first from within outward and from behind forward, then, on arriving at the nasal canal, its direction is from before backward. In its course its diameter gradually diminishes. It opens into the anterior part of the lower meatus of the nasal fossæ, by an opening which is oblique from above downward and from within outward, and which is provided with a small valve.

It is formed of three superimposed membranes.

The external is whitish, and is evidently fibrous, and also serves as a periosteum to the bones which receive the lachrymal sac; but it is also very apparent on the anterior side of the upper part of the sac which lodges the lachrymal groove.

The middle is thin and cellular: it corresponds to the cellular tunic of the mucous membrane. The internal is thick, rough, spongy, verrucous, and of a deep red. It always secretes an abundant mucus, which oozes through the rounded and oblong orifices of smallglands arranged very compactly.

This internal membrane is evidently the continuation of that of the nasal fossæ, while that which forms the lachrymal passages is continuous with the conjunctiva, so that it establishes the limit between the eye and the nose.*

* Horner has discovered a new muscle of the eye, the following discription of it is extracted from his *Treatise on General and Special Anatomy*, vol. ii. p. 408.

"The tensor tarsi is a small muscle on the orbital face of the lachrymal sac. It arises from the posterior superior part of the os unguis, just in advance of the vertical suture between the os planum and the os unguis. Having advanced three lines, it bifurcates; one bifurcation is inserted along the upper lachrymal duct, and terminates at its punctum, or near it; and the lower bifurcation has the same relation to the lower lachrymal duct. The base of the caruncula lachrymalis is placed in the angle of the bifurcation. The superior and the inferior margins of the muscle touch the corresponding fibres of the orbicularis palpebrarum, where the latter is connected with the margin of the internal canthus of the eye, but may be readily distinguished by their horizontal course. The nasal face of this muscle adheres very closely to that portion of the sac which it covers, and also to the lachrymal ducts. The lachrymal sac rises about a line above its superior margin, and extends in the orbit four lines below its inferior margin. The orbital face of the muscle is covered by a lamina of cellular membrane, and between this lamina and the ball of the eye are placed the valvula semilunaris, and a considerable quantity of adipose matter.

As the bifurcated extremities of the muscle follow the course of the ducts, they are covered by the tunica conjunctiva. When this muscle is examined from behind, the eyelids being in situ, it becomes obvious that it is concave on its orbital surface, and consequently convex on the nasal: that the muscle is an oblong body, half an inch in length, and about three lines wide, bifurcated at one end; and that it

ARTICLE SECOND.

GLOBE OF THE EYE.

§ 1972. The *globe of the eye* (*bulbus oculi*),* often termed simply the eye, is formed like an almost regular globe. In the adult its diameter is about an inch: its length, however, exceeds its breadth and its height. It occupies the anterior part of the cavity of the orbit, but passes a little before it. It is surrounded in every part by an abundance of fat, and also by the muscles which move it, and which contribute with the optic nerve, and numerous blood-vessels, to retain it in place.

It is formed by several superimposed membranes and the humours contained by them. In respect to the form and the texture of the membranes, and that of the nature of the humours, we may divide it into two parts, a posterior and an anterior, the first of which is more extensive than the other.

arises much deeper from the orbit than any acknowledged origin of the orbicularis. The superior fork, however, has a few of its fibres blended with the ciliaris.

In regard to the use of this muscle. Its attachment to the posterior face of the sac is such, that it draws the orbital parietes of the sac away from the nasal, and dilates the sac, from the nasal face of the latter being fixed to the bones. As this muscle has a cylindrical concavity on its orbital side, it is evident that when it contracts the fibres become straight, or nearly so, like the fibres of the diaphragm, and the cavity of the sac is enlarged after the same manner as the cavity of the thorax. A tendency to a vacuum being thus produced by it, the valves or folds of the internal membrane of the sac, permit the vacuum to be filled more readily through the puncta than from the nose; and the puncta being continually bathed in the tears of the lacus lachrymalis, both in the waking and in the sleeping state, the tears are constantly propelled through them by atmospheric pressure. The evacuation of the sac is no doubt accomplished by its own elasticity, and by the contraction of the orbicularis; probably in a chief degree by the latter, because in persons who have epiphora, or a tendency to obstraction in the nasal duct, the accumulation of tears and matter principally take place at night, when the action of the orbicularis is suspended by sleep. For these reasons we should argue, that this little muscle is active all the time, both night and day. To Dr. Physick I am indebted for suggesting another use for this muscle; that of keeping the lids in contact with the ball of the eye. Some persons possess unusual voluntary power of this muscle, of which I have seen two examples; one in a lady; another in a gentleman, a student of medicine. In each instance the individual could shorten so much the internal angle of the eyelids, as to conceal it, along with the puncta, in the internal canthus of the orbit."

Trasmondi, on the contrary, thinks that it acts on the lachrymal sac and passages, that it compresses the caruncula lachrymal so as to favor the excretion of the humour formed by its crypts, and that it relaxes or also tenses the membrane, so as to increase or diminish the base of the lachrymal sac, and to force the tears into the nasal canal. (*Notice sur la découverte de deux nerfs de l'œil humain*: in the *Mélanges de chirurgie étrangère*, Geneva, 1824, p. 415). Gery (*Ibid*. p. 453) does not agree with his fellow-countryman, and thinks with Horner, that this muscle serves to adapt the lids to the globe of the eye, and to direct the tears into the lachrymal sac.

F. T.

* C. A. Rudolphi, *Diss. de oculi quibusdam partibus*, Gripswald. 1801.—Id. *Ueber einige Theile des Auges* in his *Anatomisch-physiologische Untersuchungen*, vol. i. p. 1—30.—Dœllinger, *Illustratio ichnographica oculi humani*, Wurtzburg, 1817.—Edwards, *Sur la structure de l'œil*: in the *Bulletin de la soc. philom.*, 1814, p. 21.—E. Home and F. Bauer, *Observations microscopiques sur la structure de l'œil*, in *Phil. trans.*, 1822, p. 76, and in *Archiv. génér. de méd.*, vol. ii. p. 151.

The most external membrane is the *cornea*, the posterior part of which is the *opaque cornea* or the *sclerotica*, and the anterior, the *transparent cornea*. Next comes the middle membrane, the *choroid*, the anterior part of which is termed the *iris*, and below this is a third, the *retina*, which is a prolongation or expansion of the optic nerve.

I. MEMBRANES OF THE EYE.

A. EXTERNAL MEMBRANES OF THE EYE.

§ 1973. The *external* membranes of the globe of the eye are much firmer and thicker than the others. Its form is determined principally by them.

A. SCLEROTICA.

§ 1974. The *sclerotica*, the *opaque cornea*, or the *albugineous membrane of the eye* (*tunica sclerotica*, s. *albuginea*, s. *cornea opaca*), covers the posterior part of the eye, and occupies about five sixths of its circumference. It presents posteriorly, a little nearer its inner side than its centre, a round foramen, or at least it is much thinner there than in its other parts, and there presents numerous small cribriform openings, through which the fasciculi of the optic nerve communicate with the retina. It is terminated anteriorly by a broad rounded opening which receives the transparent cornea.

As it belongs to the class of fibrous membranes it is white, brilliant, fibrous, very elastic and solid. We may forcibly divide it into several layers: but these are united by intermediate filaments.

The two faces are smooth. Numerous blood-vessels, the trunks of the twigs distributed to the inner part of the eye, intimately adhere to the external; some of these vessels perforate it posteriorly, others more anteriorly at about its centre. They all proceed within its substance a greater or less distance, which is proportional to their own volume.

Smaller openings in its posterior part give passage to the ciliary nerves, which penetrate from without inward between it and the choroid membrane.

The sclerotica is not equally thick in every part. It generally diminishes much from behind forward. Posteriorly it is about a line thick, and about one half of a line at the edge of the transparent cornea.

The membrane is thinner in the points which correspond to the attachment of the tendons of the recti muscles of the eye, than between these insertions.

In the place where the optic nerve communicates with the globe of the eye, it unites very intimately with the envelope given to this nerve by the dura-mater. Although it is eight or ten times thicker, and also

firmer than this envelope, we may however consider them as identical since they do not differ essentially in regard to texture.

§ 1975. Among the superimposed layers of the sclerotica, one may be detached more or less easily from the others, and with greater facility in the early periods of life, than in the adult. This very thin layer is a prolongation, not of the pia-mater as has been supposed since Zinn's time,* but of the envelop sent by the arachnoid membrane to the optic nerve, and with which it is evidently continuous. It forms a small bursa projecting inward, around the cribriform plate, through which the optic nerve enters the eye, and is reflected from the circumference of this layer on the inner face of the sclerotica, with which it unites intimately, proceeding with it to its anterior edge.

There is then between this layer and the sclerotica, exactly the same relation as between the dura-mater and the arachnoid membrane within the skull and the vertebral column, or, employing a more general comparison, as between the hard substances, as the cartilages and the fibrous organs, covered with serous membranes and these membranes.

The inner face of this internal layer of the sclerotica, is rather intimately united to the choroid membrane by a loose cellular tissue, and also by the nerves and vessels which pass through the external capsule of the eye. We may, however, especially some days after death, separate and remove the sclerotica, without injuring the choroid membrane.

B. TRANSPARENT CORNEA.

§ 1976. The *transparent cornea* (*tunica cornea*, s. *cornea pellucida*)* which surrounds the anterior part of the eye, differs from the sclerotica in its texture so much, that it is impossible to apply the same term to these two membranes.

It represents a segment of a sphere which is a little smaller than that of which the sclerotica is the figure, so that it is more convex and projects slightly on the surface of the latter.

It is always a little thicker than the sclerotica, and its thickness is generally uniform, except at its circumference, where it gradually becomes much thinner, but only in a slight extent. Sometimes, however, it is a little thicker in the centre than on the edge. Its posterior face always describes a concavity which corresponds exactly to the convexity of its anterior face.

The conjunctiva extends towards the upper edge and the lower edge of its external face for about half a line, so that this external face is not perfectly round, but slightly elliptical. The upper face, on the

* Zinn, *loc. cit.*, p, 11.

† B. D. Manchart, *Corneæ oculi tunicæ examen anatomico-physiologicum*, Tubingen, 1743.—Hoffbauer, *Diss. de cornea ejusque morbis*, Berlin, 1820.—M. J. Chelius, *Ueber die durchsichtige Hornhaut des Auges*, Carlsruhe, 1818.

contrary, is entirely round. It terminates by a circular depression or groove which receives a prominent edge, situated on the limit between the ciliary ligament and the iris.

It always becomes much thinner and is serrated at its point of union with the sclerotica.

The two membranes are united in three different ways.

Sometimes the anterior face gradually diminishes, so that the transparent cornea is partly covered by the sclerotica.

Sometimes the two faces gradually become thinner, and the cornea is inserted in a channel grooved on the anterior edge of the sclerotica.

Finally, sometimes the internal face insensibly disappears, and the cornea rests a little on the anterior edge of the sclerotica.

The first is the most common, and the last the rarest arrangement.

§ 1977. The transparent cornea is formed of several layers having between them a limpid fluid, which are separated more easily than those of the sclerotica, and which are united by a loose cellular tissue.

This fluid transudes after death. Its evaporation causes in part the opacity and collapse of the cornea, which then occur.

The posterior face of the cornea is covered by a thin, pellucid, homogeneous and slightly extensible membrane, which tears evenly when forcibly extended and is easily detached from it by a slight maceration or by boiling.* This membrane is attached to the edge of the cornea, and does not proceed at least sensibly on the iris. It has been termed the *membrane of the aqueous humour* (*mem. humoris aquei*) ; this term is inappropriate, as it does not seem to secrete the aqueous humour(*a*).

B. CHOROID MEMBRANE AND IRIS.

§ 1978. Directly below the external tunic of the globe of the eye is another membrane of about the same extent and also composed of two halves differing in their organization. The posterior is termed the *choroid* membrane, and the anterior, which is much smaller, the *iris.*

* B. Duddell, *Treatise on the diseases of the horny coat in the eye*, London, 1729, —J. Descemet, *An sola lens crystallina cataractæ sedes*, Paris, 1758.—Id. in the *Mém. des sav. étrangers*, book i.—Demours, *Lettre à M. Petit*, Paris, 1767.—The details of the quarrel between Descemet and Demours, in regard to the discovery of this membrane, are given in the *Journ. de méd.*, 1769, 1770, 1771.

(*a*) Professor Schlemm of Berlin, asserts that the cornea is well supplied with nerves: "They arise from the ciliary nerves which divide behind the ciliary ligament into a superficial and a deep-seated order of filaments. The latter are larger and more numerous, and are distributed to the iris; the superficial however enter the sclerotica on a level with the ciliary ligament, from whence they extend forward to enter the groove of the edge of the cornea which is united with the corresponding border of the sclerotica, and traverse the posterior part of the cornea until they become lost by their extreme tensity upon that membrane."

† S. Sawrey in 1807 claimed the discovery of this membrane, which had been vaguely imagined by Duddell, and which in fact had been discovered by Demours or Descemet. (*An account of a newly discovered membrane in the human eye*, London, 1807.) F. T.

A. CHOROID MEMBRANE.

§ 1979. The *choroid membrane* (*tunica vasculosa*, s. *choroidea*) * corresponds to the sclerotica. It extends from the anterior edge of this membrane to the entrance of the optic nerve for which it presents a rounded opening and to which it is directly united, particularly along the course of the nerves and vessels, in its whole extent by rather a loose cellular tissue. The union between the two membranes is only interrupted here and there by the ciliary nerves and the long ciliary arteries, which proceed between them from behind forward.

The inner face of the choroid membrane is not attached to the retina, although they are in direct contact.

§ 1980. Near the anterior extremity of the choroid membrane the mucous tissue becomes much thicker in the outer face of the membrane, and forms a whitish ring about one line broad called the *ciliary ligament*, the *commissure of the choroid membrane*, Ch. (*L. ciliare, orbiculus ciliaris, circulus ciliaris, plexus ciliaris*). This ring attaches the choroid membrane to the sclerotica more firmly than in the rest of its extent; but it is united to the sclerotica much less intimately than to the choroid membrane, which is thinner in the part corresponding to it, so that the latter can be easily detached from the opaque cornea, while this is not the case with the ciliary ligaments, which may consequently be considered as forming part of it.

The internal circumference of the ciliary ligament is bounded by a narrow but very evident white projection, which fits exactly into a groove on the circumference of the inner face of the transparent cornea.

Before this ring is the *iris*, which is intimately united with it.

B. CILIARY BODY.

§ 1981. The inner face of the choroid membrane is singularly changed in this place, where it forms the *ciliary body* (*corona ciliaris*, s. *orbiculus ciliaris, corpus ciliare, tunica ciliaris*)†. In fact on leaving the external edge of the ciliary ligament it forms, inward and for the breadth of about a line and a half, numerous small folds, whence come a great number of slightly prominent rays which go from without inward. Another smaller and more internal circle then succeeds, formed by more distinct folds, the inner edge of which is convex and

* Ruysch, *Ep. anat.* xiii.—L. Heister, *Diss. de tunicâ choroideâ*, in the *Fasc. diss. med.*, Leyden, 1745.—B. S. Albinus, *De tunicâ Ruyschianâ et choroideâ oculi*; in the *Ann. acad.*, l. vii., cap. iv.

† J. G. Zinn, *De ligamentis ciliaribus programma*, Gottingen, 1753.—Doellinger, *Sur les procès ciliares dans l'œil de l'homme*; in the *Nov. acta nat. cur.*, vol. ix., p. 274.

which become more prominent from without inward, and terminate in a rounded edge. These folds, which are termed *ciliary processes* (*processus ciliaris*), are fewer in number although very numerous, as there are about seventy. They are however much more remote from each other than the external. Their anterior extremity is loose. They are attached to the large circumference of the crystalline capsule by the anterior part of their adherent edge. The posterior part of all this region of the choroid membrane adheres very intimately to the external face of the ciliary ligament, for its folds are received into the depressions of this latter, the form of which corresponds exactly to theirs, so that in this part the inner face of the choroid membrane is firmly united to the subjacent parts, and when we attempt to detach it in the recent state the ciliary ligament is generally torn.

§ 1982. The choroid membrane is soft and thin, but its tissue is firm and solid. On removing the coat of the pigment it appears whitish and slightly transparent. It is almost entirely formed by blood-vessels which are very distinct on its two faces, especially on the external.

Some of these vessels are arteries and others veins,* but the latter are much more numerous.

§ 1983. The arteries of the choroid membrane, termed the *ciliary* arteries (*A. ciliares*), are principally of two kinds.

The long *ciliary* arteries (*A. ciliares longæ*) are longer and more superficial than the others ; there are generally but two, an external and superior and an internal and inferior. These two arteries are situated more or less nearly opposite each other. After passing through the sclerotica at its posterior part they are situated on the anterior part of the choroid membrane, proceed directly from behind forward without sending off any very large branch, and are distributed in the iris. Hence they do not really belong to the choroid membrane.

The *short* or *posterior ciliary* arteries, *uvéales*, Ch. (*A. ciliares breves, s. posteriores*), are much smaller but more numerous than the long. There are usually twenty or more of them of different sizes. They perforate the sclerotica more posteriorly and internally than the preceding, nearer the optic nerve, and soon enter the choroid membrane. They there divide into twigs which are given off at acute angles, frequently anastomose together, especially in the anterior part of the choroid membrane, and form forward, behind the external edge of the ciliary body, a circle composed of a very complex network.

The twigs they produce in dividing are parallel, and proceed very closely from behind forward. At the posterior part of the choroid membrane they are situated on its outer, face, but towards the centre of the globe of the eye they pass through it and go to its internal face,

* J. E. Hebenstreit, *De vasis sanguiferis oculi*, Leipsic, 1742.—J. G. Zinn, *De vasis subtilioribus oculi et cochleæ auris internæ*, Gottingen, 1753.

where consequently they are more distinctly perceptible than in the external.

§ 1984. The veins of the choroid membrane are easily distinguished from the arteries by their course and their larger size.

Their branches are very compact, radiate from before backward and from without inward, form large arches, and divide into twelve or fourteen small twigs which pass through the sclerotica at about the centre of the globe of the eye, proceed a few lines from before backward in this membrane, and reunite in four or five larger trunks which pass out of the eye at its posterior part and enter the ophthalmic veins. Four of these trunks are much larger than the rest, some of which proceeding also from before backward, receive the twigs coming from the iris.

These veins have been termed from their numerous curves the *vasa vorticosa*. They are more superficial than the arteries, and are also more external at the anterior part of the choroid membrane and form its external layer.

Besides these veins there are others, the *long* or *anterior ciliary* veins (*V. ciliares longæ*, s. *anteriores*), which accompany the long ciliary arteries, return from the iris, and receive no considerable ramifications from the choroid membrane*.

§ 1985. The blood-vessels and the mucous tissue which supports them are the only organic elements visible in the choroid membrane. Those fibres which are directed from before backward, and are admitted by several anatomists to exist, have never been seen by us, and even the ciliary body seems only a very complex tissue of vessels.

§ 1986. The internal face of the choroid membrane does not appear perfectly smooth to the naked eye, but presents, particularly if the eye be injected, numerous small floating flocculæ which give it a downy appearance; this is much more evident if we use the microscope. These flocculæ are very well developed in the ciliary body. They are mostly formed by a very compact tissue of vessels, particularly in the posterior region of the choroid membrane, the inner face of which is almost entirely covered by them, while they leave it much looser anteriorly.

§ 1987. The internal face of the choroid membrane cannot be considered as a special membrane in man, as we cannot divide it into two layers. Ruysch first asserted this opinion, while his son termed this coat the *tunica Ruyschiana*. It is also incorrect to admit as the *villo-glandular tunic* † or the *supra-choroid membrane* (*membrana supra-choroidea*),‡ another membrane situated on the outside of the choroid, which would be the *second middle tunic* of the eye, or even

* See the plate of the vessels of the choroid membrane, in Sœmmerring. *Ueber das feinste Gefassnetz der Aderhaut im Augapfel*, 1818.

† B. A. Stier, *De tunicâ quadam oculi novissime detectâ*, Halle, 1759.

‡ Montain, in the *Journal de méd.*, vol. lvii.—*Bull. de la soc. méd. d'Emul.*, 1807, p. 430.

the *third*, by admitting the tunica Ruyschiana, and which has been regarded as belonging to the class of serous membranes.*

Finally it is still more incorrect to represent the choroid coat as formed by five superimposed layers,† of which the second, third, and fourth form the proper choroid membrane, and the other two the two membranes mentioned.

C. IRIS.

§ 1988. The *iris*‡ is a circular membrane perforated in its centre with a rounded and nearly concentric opening, termed the *pupil*. This opening is a little narrower on its inner side, which looks towards the nose, than in the rest of its course,§ and its external edge is attached to the anterior edge of the choroid membrane, viz. to the ciliary ligament. Finally, it is entirely loose in the chamber of the eye, where it forms a transverse septum extended from above downward and from right to left, which divides this chamber into two compartments, an *anterior* and a *posterior*, communicating by the opening of the pupil.

The iris forms the posterior wall of the *anterior* chamber of the eye, and the transparent cornea forms its anterior wall. It constitutes, on the contrary, the anterior wall of the *posterior* chamber, the posterior wall of which is formed by the anterior face of the crystalline lens, and the anterior edge of the ciliary body.

The posterior wall of the iris is also termed the *uvea*.

In man it is straight and not convex anteriorly, as has been asserted.|| It is nearer the anterior face of the crystalline membrane than the posterior face of the transparent cornea.¶ The space on its external face where it is greatest, between it and the crystalline membrane, is not even half a line, but in the centre it is only a quarter of a line. Its centre is about a line distant from the transparent cornea, but its outer edge is much nearer this membrane.

Its extent from without inward varies extremely. It is not only often morbidly dilated to such an extent that the pupil almost entirely disappears, and sometimes contracts so much as to be invisible or nearly so, but also in the normal state it dilates and contracts rapidly under the influence of certain external and internal causes.**

* Doellinger, *loc. cit.*, p. 6.
† Hovius, *De circulari humorum motu*, Leyden, 1716, p. 29.
‡ Maunoir, *Mémoire sur l'organisation de l'iris, et l'opération de la pupille artificielle*, Paris, 1812.
§ Winslow, *Observations sur la mécanique des muscles obliques de l'œil, sur iris, &c.*, in the *Mém. de Paris*, 1721, p. 463.—Littleton, *Sur les causes d'où dépend la largeur de la pupille*; in Bradley, *Med. and phys. Journal*, vol. xxxvi. 39.
|| Petit, *Mém. sur les yeux gelés, dans lequel on détermine la grandeur des chambres qui renferment l'humeur aqueuse*; in the *Mém. de Paris*, 1723, p. 51.
¶ *Ibid.*, 1728, p. 295 and 408.
** J. G. Zinn, *De motu uveæ*: in the *Comm. Gott.* vol. i.—Fontana, *Dei moti dell'iride*, Lucca, 1765.—J. F. Blumenbach, *De oculis leucaethiopum et motu*

By carefully examining all the circumstances which belong to these two phenomena we conclude that the active state of the iris is that of dilatation, the passive that of contraction.

§ 1989. This membrane is much thicker in its larger and external than in its internal part, where it seems to be divided obliquely from without inward and from before backward, and terminates there in a thin edge. The most internal part excepted, the iris is three or four times thicker than the choroid membrane.

Its external and internal edges are more deeply coloured than the intermediate parts. The darkest part of the membrane is a small portion of the inner surface situated a little on the outer side of the inner edge. This dark place and the portion of the iris between it and the pupil is called the *small* or the *internal circle* (*annulus minor*, s. *internus*). The rest of the membrane is termed the *great* or the *external circle* (*annulus major*, s. *externus*).

The whole of the anterior face of the iris is entirely coloured. The posterior is coloured only in the portion corresponding to the small circle: all the rest is whitish, but covered with a dark mucus (§ 1997). The anterior face is the seat of the peculiar colour of the eyes. It is everywhere covered by very minute and differently coloured flocculæ, which with the streaks of pigment above-mentioned on the posterior face are the grounds of the different colour of the eyes.

§ 1990. We observe both on the anterior and the posterior face of the iris circular fibres which are slightly undulatory, and longitudinal fibres which radiate from without inward. The first are particularly evident near the outer and inner edge. The others are more distinct on the anterior face; they are larger and more perceptible in the great than in the small circle.

Some of these fibres are whitish and alternate with others less manifestly grey. The first divide frequently at acute angles into a considerable number of small branches, which anastomose on the outer circumference of the small circle, giving rise to arches which are convex forward, and thus form a complex crown from which smaller and closer longitudinal striæ emanate; these radiate in the internal circle to the edge of the pupil.

§ 1991. The iris is soft and spungy.

It is mostly composed of nerves and vessels united by mucous tissue, and very probably also of fibres, the seat of the contraction and dilatation mentioned above (§ 1988).

iridis, Gottingen, 1785.—F. Hildebrandt, *De motu iridis*, Brunswick. 1786.—Doemling, *Ueber die Ursache der Bewegung der Regenbogenhaut*; in Reil, *Archiv. für Physiologie*, vol. v. -Caldani, *Intorno di movimenti dell'iride*: in the *Mem. della soc. ital.* vol. xiv. pt. 2, p. 101—114.—C. A. F. Kluge, *Diss. de iridis motu*, Erford, 1806.—S. S. Guttentag. *De iridis motu*, Breslau, 1815,—Littleton, *On the causes which influence the size of the pupil*; in the *Lond. med. and phys. journal*, vol. lvi., 1816, p. 89, 265.—E. H. Weber, *Tractatus de motu iridis*, Leipsic, 1821.

§ 1992. The *nerves of the iris* (*N. ciliares*)* arise from the irst branch of the fifth pair, from the sixth pair and the great sym›athetic nerve, are about twenty in number, and perforate the sclero-.ica a little behind the centre of the great diameter of the eye, pass ome lines even in the substance of this membrane, are then situated etween it and the outer face of the choroid membrane, adhere but lightly to these two coats, proceed from behind forward with-ut giving off any branch, and arrive at the external edge of he ciliary ligament directly behind which they generally divide at n acute angle into two branches. These branches go forward on the nterior face of the choroid membrane under the ciliary ligament and rrive at the anterior face of the iris, where they form the whitish nd radiating filaments there observed: in the course of these are ounded filaments which are perhaps ganglions.

The ciliary nerves are unusually large in proportion to the iris, ıd hence this membrane is one of the parts of the body, if not the ery part, which possesses the most nerves.

§ 1993. The *vessels* of the iris arise principally from the long r anterior ciliary vessels.

Each of the two *long ciliary* arteries divides below the ciliary liga-ent into two branches, which go to meet the two corresponding anches of the other arterial trunk, and which by anastomosing with em form on the external edge of the iris a crown slightly convex rward, from which numerous twigs arise; the latter radiate towards e inner edge of the membrane and still bifurcate, communicating re and there by transverse ramuscules. They anastomose together the outer edge of the internal ring so as to form at the opening of the pil a more or less concentric circle; from this, new radiating twigs ise and go to the small circumference, but several of them however me directly from the rays of the great external arterial circle.

Besides the arterial twigs, the iris also contains many little veins, ich enter some into the long ciliary veins and others into the vasa rticosa. As they cannot be filled except by injecting them through arteries, or as when injected through the venous trunks they are ed less perfectly than the arteries, the veins seem fewer and form t small arches.†

These vessels are most apparent on the anterior face of the iris, to ich they seem but loosely attached.

They certainly carry red blood, since the membrane bleeds when unded, and their reddish colour is very evident in the eyes of inos, where the pigment continues colourless from a primitive de-ation of formation.‡

§ 1994. Even in the most perfect injections, the iris still seems to formed of more or less evident yellowish white fibres, which as we

Tiedemann, *Diss. de ganglio ophthalmico et nervis ciliaribus animalium*, dshut, 1815.

Zinn, *loc. cit.*, p. 94.

Monro, *Ueber den Bau der Fische*, Leipsic, 1787, p. 71.

have already stated, seem to be the seat of the motions executed by this membrane.

Several anatomists, as Drelincourt,* Ruysch,† and Monro,‡ formally adopt this opinion, or are, like Zinn,§ very much inclined to it.

They assert that some of the fibres are radiated and others circular: the first extend from the external to the internal circle, where Ruysch thinks that they are even attached by small tendons: the circular form most of the internal circle of the iris.‖ In contracting, the longitudinal fibres dilate the pupil, while the circular contract it.

Beside the circular fibres which are admitted by Monro and Ruysch, we have sometimes observed on the anterior face of the iris, towards its outer edge, some very evident circular fasciculi, corresponding to those discovered in the same place in the eye of the ox by Monro;¶ but neither the anatomy, nor the observation of the vital phenomena of the iris, seem to us to justify the admission of radiating longitudinal fibres.

§ 1996. The iris in man can be divided, but not naturally, into two layers, an anterior or the proper iris, and a posterior or the *uvea*, and these cannot be separated except in small portions. It is also uncertain whether its anterior face be lined by a prolongation of the membrane of Demours; at least it is here also much thinner than on the posterior face of the transparent cornea, and its nature is different.

§ 1997. Opinions vary in regard to the manner in which the iris and choroid membrane are united. Some assert that the iris is a prolongation of the latter; others think that it should be regarded as a distinct membrane.

The arguments in favour of the second opinion are:

1st. The greater thickness of the iris.

2nd. Its numerous nerves, while the choroid membrane has none.

3rd. The fewer vessels which carry blood to it, which differ in their origin and arrangement from those of the choroid membrane.

4th. The difference between the two membranes in respect to their vital phenomena, since the iris is highly contractile, while the choroid membrane possesses no contractility.

We may also add that the great edge of the iris is easily detached after maceration, which does not continue long enough to destroy the continuity of the tissue either of this or of the choroid membrane.

* *Præelud. anat. Opp. omn.*, p. 195.
† *Respons. ad epist. anat.* xiii., *Thes. anat.* ii., p. 13-15.
‡ *Loc. cit.*, p. 110-115.
§ *Loc. cit.*, p. 91, 95.
‖ Monro (*loc. cit.*, tab. 3).
¶ *Loc. cit.*, tab. 2.

D. PIGMENT.

§ 1997. The two faces of the choroid membrane and the posterior face of the iris or the uvea, in the normal state, are covered with a brownish coloured substance, termed the *pigment* (*pigmentum nigrum*.* In some parts, particularly on the posterior face of the iris, this pigment can be detached in a greater or less extent as a fine and coherent membrane. In some places, particularly on the inner face of the ciliary body, especially between the processes, and the posterior face of the iris, and generally in the internal regions, it is more abundant, deeper in colour, and more attached to the adjacent parts. There is less on the external than on the internal face of the choroid membrane, although that which exists there does not differ essentially from that found in other parts. There is none on the posterior part of the inner face of the choroid membrane around the opening which gives passage to the optic nerve, so that the choroid coat is white in this place.

The pigment is composed of a peculiar mucous substance and of another colouring substance, the first of which connects all the molecules together, so that they have the form of a membrane. In regard to mechanical structure, this colouring substance is composed of globules. These globules are not perfectly black, but only present occasionally small points of a deeper tint. Their form is irregularly round. They are smaller in the ciliary processes, but are arranged in several superimposed layers more uniformly black. In regard to their chemical composition, they contain a considerable quantity of iron and also of carbon, which forms almost half of them, so that of all parts of the body they contain the most of this elementary substance.† The iron is the cause of their heaviness but not the source of their colour, since the quantity of this metal in the rete mucosum of the skin of the negro is small, and even less than in that of the Caucasian race.‡

The pigment is essentially so similar to the rete mucosum, that we may admit they are the same, whence it follows that the pigment is not a secreted fluid but a solid tissue, an organic element possessing a special form.

* Mondini, *De oculi pigmento*; in the *Comm. Bonon.*, vol. vii. p. 29.—Elsaesser, *De pigmento oculi nigro*, Tubingen, 1800.—L. Gmelin. *Diss. sistens indagationem chimicam pigmenti nigri oculorum taurinorum et vitulinorum, adnexis quibusdam in id animadversionibus physiologicis*, Gottingen, 1812.—F. Mondini, *Sul nero pigmento dell' occhio*; in the *Opuscoli scientifichi di Bologna*, 1818, fasc. vii., p. 15–27.—Berzelius, *Djurkemi*, ii., p. 201.

† Berzelius in the *Med. chir. trans.* vol. iii., p. 255.—Coli, in Mondini jun., *loc. cit.*, p. 17.

‡ Coli, *loc. cit.*, p. 26.

C. RETINA.

§ 1998. The third distinct membrane of the eye is the *retina.** It is the expansion of the optic nerve, the anterior extremity of which contracts much in passing through the sclerotica, but more gradually and more insensibly at its inner than at its outer part, so that the nerve describes an arch much larger outward than inward.

Before the anterior extremity of the optic nerve the sclerotica presents a surface with numerous foramina, through which the fasciculi of the nerves pass. Beyond this cribiform plate the extremity of the nerve forms a small mammillary prominence, from which the expansion of the retina arises; this terminates forward at the posterior extremity of the ciliary body by a straight edge more or less evidently enlarged, which is unconnected with the crystalline capsule.†

§ 1999. The retina is white, thin, homogeneous, and destitute of fibres, equally thick in every part, excepting one small point of its extent posteriorly. It is composed, in a measure, of two layers, an external, which is medullary, and an internal, formed by cellular tissue and vessels. The latter separates the medullary layer from the vitreous body. We cannot however insulate the two layers from each other so as to obtain one alone in the form of a connected and coherent whole, although the internal appears in this form when putrefaction has destroyed the medullary layer. Hence we cannot consider the retina except as formed by the union of two special and distinct membranes; but we really find on its external face a very thin membrane, ‡ very analogous to the serous membranes, which

* J. H. Moeller, *De tunicâ nerveâ et nervo optico*, Halle, 1749.—B. S. Albinus, *De tunicâ quam vocant retinam*; in the *Annot. acad.*, book iii., cap. xvi., *Ann.* 1756.

† Several old anatomists, particularly Winslow, Cassebohm, Ferrein, Lieutaud, and Haller, whose arguments have been collected by Zinn (*loc. cit.*, p. 114), and Monro among the moderns (*loc. cit.*, p. 96), have asserted that the retina passes below the ciliary body, and that it extends to the great edge of the crystalline capsule, to which it is attached. But careful dissections have led us to embrace the contrary opinion, which has been supported by Morgagni, Zinn, and some of their predecessors. Monro says that we can prove that the retina extends to the crystalline humour: 1st, by resting the eye on the transparent cornea, and there making a transverse section which includes all the membranes with the vitreous body: 2nd, by raising the ciliary body and carefully removing the pigment with a pair of forceps. But in following these two processes we have always recognized that the retina terminates evidently at the posterior extremity of the ciliary body, and we have even found that the layer still partially covered by the pigment, which extends from the hyaloid membrane to the crystalline capsule, was more transparent than the retina. The eyes of the fœtus are better than those of the adult to demonstrate that Monro's opinion is false, because in them the retina is more opaque, and the external wall of the canal of Petit is thinner.

‡ Jacob, *Newly discovered membrane in the eye*; in Thomson, *Annals of philosophy*, July, 1818, p. 74; *Phil. trans.*, 1819, p. 300; *Journ. compl. des sc. méd.*, vol. xi., p. 187.—Jacobson, *Mémoire sur une humeur peu connue de l'œil, et sur les maladies auxquelles donnent quelquefois lieu les changemens survenus dans la sécrétion*; in the *Act. soc. reg. med. Hafn.*, vol. vi.; and *Bull. de la soc. méd. d'Emul.*, September, 1822.—G. Mirault, *Sur une hydropisie particulière du globe de l'œil*; in the *Archiv. gén. de méd.*, vol. ii., p. 48.

seems to us to be the seat of the ossifications sometimes occurring between the choroid membrane and the retina.

§ 2000. The retina is extended on the vitreous body, and forms there no fold, except in a small extent of its posterior part, at some distance from the entrance of the optic nerve, and on its outer side.

There in fact the membrane presents a fold, which is directed inward, a *yellow spot*, and a round place, where it is extremely thin.*

The direction of this fold is transverse from within outward. It commences at some distance from, or directly at the side of the entrance of the optic nerve by a small point, and is terminated by a blunt extremity. It is generally from a line and a half to two lines long. It is commonly single, but sometimes also it is double. In some subjects it is deficient.† Home asserts even that it is never natural, and that its formation depends on the more intimate union in this place between the retina and the hyaloid membrane. But the error of the English anatomist is proved by the facts that the fold is observed even when the connections between the two membranes are unaltered, and that it is much more evident in youth than subsequently.

The retina presents at the same place a yellowish spot of the same size, which is darker in the centre than on the edges. It is generally one line high, and from one and a half to two lines broad. But it has not the same extent and degree of colour in every part, although these two peculiarities are not necessarily connected with the sense of vision.

The retina is much thinner in this place than in the rest of its extent, particularly in the centre of the yellow spot, where some admit the existence of a foramen, while others, and according to our dissections more correctly, think that there is a place entirely destitute of medullary substance, of an oval form and surrounded with smooth and distinct edges.

This thin place becomes very apparent only when the vitreous humour is compressed to push the fold outward and to efface it.

* Buzzi, in the *Opusc. sulle scienze e sulle arti*, Milan, vol. v., 1784, and vol. ii.—Sœmmerring, *De foramine centrali limbo luteo cincto retinæ humanæ*; in the *Comm. soc. Gott.*, vol. xiii., 1795-1798.—P. Michaelis, *Ueber einen gelben Fleck und ein Loch in der Nervenhaut des menschlichen Auges*; in the *Journal der Erfindungen*, part xv., p. 1-17, 1796, and cah. xvii., p. 133.—J. C. Reil, *Die Falte, der gelbe Fleck und die durchsichtige Stelle in der Netzhaut des Auges*; in the *Archiv. für die Physiologie*, vol. ii., p. 468-797.—E. Home, *An account of the orifice in the retina of the human eye*; in the *Phil. trans.*, 1798, p ii.—*Exposé des résultats de plusieurs recherches sur la tache jaune, le pli et le trou central de la rétine, d'après deux mémoires communiqués par Marc et Léveille*; in the *Mémoires de la soc. méd. d'Em.*, vol. i., 1802, p. 364-397.—J. M. Wantzel, *Ueber die Home'schen Entdeckungen, das Loch, die Falte und den gelben Fleck im Mittelpunkt der Netzhaut betreffende*; in Rosenmuller and Isenflamm, *Beyträge für die Zergliederungskunst*, Leipsic, 1800, vol. i., part ii., p. 204.

† Reil, *loc. cit.*, 470.

II. HUMOURS OF THE EYE.

A. VITREOUS HUMOUR.

§ 2001. The posterior part of the eye is occupied by the *vitreous humour* or *body* (*humor vitreus*, s. *corpus vitreum*), which corresponds in its situation to the choroid membrane, and the retina.*

This humour is perfectly transparent, thin, and formed almost entirely of water, which contains a small quantity of the hydrochlorates and the lactates, with still less of albumen and soda.† It is contained in a special, very thin, delicate, transparent membrane, which every where surrounds it, and which is termed the *hyaloid* membrane (*tunica hyaloidea*). This membrane sends internally numerous prolongations in the spaces of which the liquid is contained as in so many cellules. The union of the membrane and of the liquid which forms it, is, properly speaking, the *vitreous body* .

This body presents on its anterior face a slight cavity which is connected with the crystalline capsule, the posterior part of which is situated there, and adheres to it so intimately in the normal state that it cannot be detached from it, at least when the eye is perfectly fresh, without tearing the hyaloid membrane.

§ 2002. Between the great edge of the crystalline capsule and the anterior part of the hyaloid membrane, a little behind the anterior edge of this latter, is a thin layer, termed the *ciliary* layer (*lamina ciliaris*, *zonula Zinnii*), which is extended like a bridge on the most anterior part of the vitreous body, in connection with which it circumscribes a triangular space, the base of which is formed by the posterior part of the circumference of the crystalline capsule, while the two branches are constituted, one by the layer, and the other by the most anterior part of the vitreous body.

This empty space surrounds the crystalline and the vitreous body. It is termed the *canal of Petit* (*canalis*, s. *circulus Petiti*). It is easily demonstrated by inflating it with air.

* F. Martegiani (*Novæ obs. de oculo humano*, Naples, 1814, p. 19) admits between the vitreous body and the retina an empty space, in the centre of which is the central artery of the retina, termed by him the *area Martegiani*, in honour of his father. J. Cloquet seems to admit the existence of this deviation, for he says (*De la squelettopée*, Paris, 1819, p. 72), that the hyaloid membrane is reflected on itself on a level with the entrance of the optic nerve into the eye, to form a canal which passes from behind forward directly through the vitreous body. He proposes to call this passage the hyaloid canal, and asserts that it always exists in man. F. T.

† According to Berzilius (*Animal fluids*; in the *Med. chir. trans.*, vol iii., p. 253), one hundred parts of the vitreous humour contains 98,40 of water. 0,16 of albumen, 1,42 of the hydrochlorates and lactates, 0,02 of soda and an animal matter completely soluble in water.

The ciliary layer presents numerous fissures, the direction of hich is from before backward and from within outward, because it orresponds exactly to the inner face of the ciliary body, which is ntimately united with it, and the folds of which are situated in its epressions. Its external face seems blackish after the ciliary body s removed, because the pigment remains attached to it there. When he canal of Petit is inflated, it is raised, its grooves become more uperficial, and its external face seems formed of rounded or trian-ular eminences which project but slightly and are near each other.

This layer is thicker than the hyaloid membrane; still as it is nited with this latter, and as the posterior edge of the layer is con-nuous with it, we have reason to say that the hyaloid membrane is ivided at its anterior part into two layers, of which the external ives rise to the ciliary layer, while the internal is adapted to the osterior face of the crystalline capsule.

Ribes* asserts that canals exist between the ciliary layer and the iliary body, which canals conduct the aqueous humour in the cham-ers of the eye, and take it up again from these two cavities. He apports this opinion by the dilatation of these pretended canals in n eye affected with hydrophthalmia, and the escape of the vitreous umour, when the eye is suspended by the optic nerve, after remov-ig the transparent cornea. But these facts do not demonstrate it ufficiently. The first phenomenon depends probably on the gene-al accumulation of serum in the eye, as there is also a considerable ollection of serum between the crystalline lens and the vitreous ody. We have every reason to think that the second depended on e pressure of the vitreous body on a part which ought to yield more sily after cutting the transparent cornea.

III. CRYSTALLINE LENS.

§ 2003. The *crystalline lens* (*lens cristallina*)† is a soft, rounded ody, perfectly transparent in the normal state, the breadth and ight of which are almost double its thickness, and the posterior ce of which is much more convex than the anterior; at least an verse relation between its two faces rarely exists, and they are ore frequently similar. The posterior face is generally a segment a sphere about from six to nine lines in diameter, while the iterior is a segment of a sphere about five lines in diameter.

* *Mém. de la soc. méd. d'émul.*, vol. viii. p. 622—624.

† A. F. Walter, *De lente cristallina oculi humani*, Leipsic, 1712.—Petit, *Mé-ire sur le cristallin de l'œil de l'homme, des animaux à quatre pieds, des oiseaux des poissons*: in the *Mém. de Paris*, 1730, p. 4—33.—S. G. Sattig, *De lentis ystallinæ structurâ fibrosâ*, Halle, 1794.—B. F. Baerens, *Diss. sistens lentis crys-llinæ monographiam*, 1819.—Leiblein, *Bemerkungen über das System der Krys-llinse bey Saughthieren und Vogeln*, Wurzburg, 1821.

The thickness and the convexity of the crystalline lens are not always in the same proportion, as there is no constant relation between these two qualities and the breadth and height of the lens.

The crystaline lenses of the two eyes in the same man sometimes differ very much in form.

This body is situated before the vitreous body, the concave anterior face of which receives its posterior face, below the ciliary body, the internal face of which is partly attached to its great edge. It is situated behind the iris, with which it is not connected.

It however is not loose. A thin but solid membrane, which is transparent and much thicker than that of the virteous body, exactly envelops it in every part.* This membrane, termed the *crystalline capsule* (*capsula cristallina*), is the medium of connection between the crystalline lens and the adjacent parts.

The crystalline lens is loose in its capsule. It is at most attached only by extremely minute vessels, which are detached from this membrane and enter its substance.

Between it and the capsular membrane is a transparent and very thin fluid, termed the *humor of Morgagni* (*liquor Morgagnii*).†

§ 2004. The crystalline lens is formed of two substances, one external and soft, the other internal and harder. These two substances blend together imperceptibly. The first is termed the *cortical layer*, and the second the *nucleus*. The cortical substance can be easily separated from the nucleus by crushing it between the fingers.

A special process is necessary io demonstrate this texture; but when the most complex means are employed, the crystalline lens is proved to be much more complicated than it seems at first view, and it may constantly be reduced into a certain number of parts.‡

In fact by maceration and by the action of acids this body is divided in its whole extent from before backward into several triangular segments, the summits of which are turned inward and the bases outward, and which unite in the centre of the lens. Besides, each segment also divides into numerous small laminæ, which are situated one above another from without inward, and which cover each other like the coats of an onion.

These layers are reflected from before backward on the outer edge of the crystalline lens, in the centre of which they acccordingly terminate by two points, an anterior and a posterior.

* Petit, *De la capsule du cristallin*; in the *Med. de Paris*, 1730, p. 622—613.

† Graefe, *Ueber die Bestimmung der Morgagnischen Feuchtigkeit der Linsenkapsel und des Faltenkranzes*; in Reil, *Archiv. für die Physiologie*, vol. ix., p. 225—236, and in *Abhandlungen der Erlanger Soc.*, vol. i., p. 389—396.

‡ A. Leeuwenhoek, *De formatione humoris crystallini in variis animalibus, de substantia fibrosa quæ in oculo apparet, &c.*: in the *Arc. nat. detect.*, Delft, 1695, p. 70.—Morgagni, in the *Epist. anat.* A. 30, 31, 32, 33.—Stattig, *De lentis crystallinæ structura fibrosa*, Halle, 1793.—Young, in the *Phil. trans.*, 1793.—Monro, *On the structure of the body of the crystalline lens, and whether the fibres which enter into its composition are muscular*; *loc. cit.*, p. 85.

Their anterior half is often detached from the posterior, and the whole crystalline lens seems more or less evidently divided into an anterior and a posterior half by a fissure which extends from the circumference to the centre.

The layers which compose the crystalline lens are united by fibres which extend from one to another. They are likewise composed of fibres, the direction of which is parallel to their proper longitudinal diameter. These fibres consequently commence at the centre of the crystalline lens. Thus the tissue of the crystalline lens is lamellar and fibrous.*

Between these layers is a diaphanous humour, more abundant on the outside than on the inside, which seems like that existing between the lens and its capsule.

The segments of the crystalline lens in respect to their thickness and their lamellar texture, are more distinct on its outer than on its inner side. The fibrous texture is more evident in the inner part.

§ 2005. The crystalline lens almost entirely dissolves in water, excepting a small quantity of a transparent and insoluble membranous substance. Berzelius has found in it of one hundred parts: of water, 58.0; of a peculiar substance, 35.9; of hydrochlorates, lactates, and animal matter, all soluble in alcohol 2.4; of animal matter, soluble only in water, with some phosphates, 1.3; of insoluble membranous residue, 2.4.†

It is particularly worthy of notice that, excepting the colour, the peculiar substance which is coagulated by heat is perfectly similar in chemical composition to the coloring matter of the blood. It contains a little iron, while there is much carbon and iron in the pigment. The blood then seems to be decomposed, as the aqueous and vtireous humours contain only the water which contributed to form it. Hence why these two humours do not coagulate.

§ 2006. The *crystalline capsule* receives blood from the central artery of the retina and the vessels of the ciliary body.‡

The central artery of the retina is distributed in great part by its anterior branches on the posterior face of the capsule, for its last ramifications on arriving at the anterior edge of the vitreous body are reflected from without inward, and converge towards the centre of this face; but there are also several small ones which pass on the external edge of the capsule and go on its anterior face.

The arteries which arise from the anterior edge of the ciliary body go exclusively on the anterior face of the crystalline capsule, and anas-

* Berzelius supposes, but wrongly, that it also includes a membrane divided into several compartments by internal septa, like those of the vitreous body (*Djurkemi*, vol. ii., p. 212). Finally, he observes, and justly, that this body cannot be referred to the class of fibrous organs, as has been done to a certain extent by Mayer (*Ueber Histologie*, p. 13), and by Heusinger unrestrictedly (*Histologie*, part i., p. 42), since it is entirely soluble in water. F. T.

† *Loc. cit.*, p. 254.

‡ J. G. Walter. *De venis oculi et arteria centrali retinæ*, Berlin, 1778.

tomose there with the ramifications of the central artery of the retina. In the fœtus they send off from behind forward numerous ramuscules, which are distributed on the posterior face of the pupillary membrane.

The vessels of the crystalline capsule and those of the pupillary membrane always correspond remarkably in regard to their arrangement and development.*

Finally the arteries of the capsule, especially those which arise from the central artery of the retina, send several very minute twigs to the lens which are distributed between its laminæ, so that the latter are not nourished, at least entirely, by absorbing the liquid which surrounds them.

Veins have not yet been strictly demonstrated in the crystalline capsule, although they are known to proceed on its posterior face. The latter empty into the veins of the choroid membrane, with which they open on the external face of the ciliary lamina.†

Farther, in the normal state there is no red blood in the crystalline lens or in the vitreous body.

We have not as yet discovered nerves in the crystalline lens nor in its capsule.

B. AQUEOUS HUMOUR.

§ 2007. The *aqueous humour* of the eye (*humor aqueus*) is a perfectly clear and transparent fluid which fills the two chambers. It is composed almost entirely of water,‡ and is formed very rapidly.

ARTICLE THIRD.

MUSCLES OF THE EYE.

§ 2008. The eye is moved by six muscles.§ Five of them arise from the floor of the orbit; the sixth comes from the lower part of its anterior circumference. They surround the sclerotica, to which they are attached and blend with it.||

* Hunter in the *Med. commentaries*, London, 1762, p. 63, *note*.

† Walter. *loc. cit.*, p. 28, 29.

‡ Berzelius (*Djurkemi*, vol. ii., p. 203) has found, in one hundred parts, 98.10 of water; some marks of albumen: 1.15 of hydrochlorates and lactates; and 0.75 of animal substance, soluble only in water.

§ C. Bell, *Recherches sur les mouvemens de l'œil et sur les usages des muscles et des nerfs renfermés dans l'orbite*; in the *Archiv. gén. de méd.*, vol. vi., p. 250 and 445.

|| The aponeuroses which terminate them have been considered, but wrongly, as a special membrane between the conjunctiva and sclerotica. (E. Home and P. Smith, *Philos. trans.*, 1795, no i., p. 11, and no. xii., p. 262.)

They are divided according to their direction into *straight* and *blique.* The first are four in number. There are two oblique mus-les.

I. STRAIGHT MUSCLES.

§ 2009. The *straight* muscles of the eye (*M. recti bulbi oculi*) are he *superior*, the *internal*, the *external*, and the *inferior;* but besides hese names, founded on the changes they cause in the situation of the lobe of the eye when they contract, they have received others also, rawn from the expression they give to the contenance, and from the tate of the mind which their action designates.

Their common character is, that they all arise from the floor of the rbit by a short and thin tendon, and are attached to the anterior part f the circumference of the sclerotica by another thin but broad tendon.

I. RECTUS SUPERIOR.

§ 2010. The *rectus superior* muscle (*M. rectus oculi superior*, s. *tollens*, s. *superbus*), arises from the periosteum of the orbit, between ie optic foramen and the upper sphenoidal fissure, between the upper art of the optic foramen and the sheath of the optic nerve, directly elow the levator palpebræ superioris muscle. It goes forward, rest-ig on the upper part of the globe of the eye, becomes broader and icker from behind forward, and is attached by a broad but thin ndon, to the sclerotica alone, two lines above the transparent cornea.

It is the second in size among the straight muscles of the eye. It a little shorter but much thinner than the following muscle.

It rises the eye.

COMMON TENDON OF THE OTHER THREE STRAIGHT MUSCLES OF THE EYE.

§ 2011. The other three straight muscles of the eye arise partly by a mmon tendon, or from a ligament which extends from the inner tremity of the sphenoidal fissure, to two or three lines before this oint.

III. RECTUS EXTERNUS.

§ 2012. The *rectus externus* muscle (*M. oculi rectus externus*, s. *ab-ucens*, s. *indignatorius*) arises by two heads. The lower, the larger, mes from the external face of the common tendon, where it adheres ry intimately to the tendon of the rectus inferior muscle. The up-r is much smaller, and is blended with the tendon of the rectus perior muscle, arises from the portion of the sphenoid bone comprised tween the optic foramen and the commencement of the sphenoidal ssure. Hence the muscle proceeds along the centre of the external

wall of the orbit, situated on the periosteum, and is attached by a thin tendon to the outer part of the edge of the sclerotica, some lines from the edge of the transparent cornea. It is broader at its centre than in the rest of its course, and is much flatter and thinner from without inward than from above downward.

It is the largest, and particularly the thickest of the straight muscles of the eye; it is a little shorter, but infinitely thicker than the obliquus superior muscle.

It carries the eye outward, and acts when looking to the outside.

IV. RECTUS INFERIOR.

§ 2013. The *rectus inferior* or the *depressor oculi* muscle (*M. rectus oculi inferior, s. deprimens, s. humilis*), unites with the lower head of the rectus externus and rectus internus muscles, arises from the common tendon, and never comes from the sheath of the optic nerve. It goes from before backward, and from above downward under the optic nerve, and is attached to the sclerotica.

It is the third in size of the recti muscles of the eye, but it is thinner and shorter than the rectus internus muscle.

It depresses the eye.

V. RECTUS INTERNUS.

§ 2014. The *rectus internus* muscle (*M. rectus oculi internus, s. adducens, s. amatorius, s. bibitorius)*, arises by two heads. The inferior or external comes from the upper and internal part of the common tendon. The superior or internal is the large, and arises from the inner part of the sheath of the optic nerve. This latter blends with the origins of the rectus superior and the levator palpebræ superioris muscles. Thence the muscle goes inward and forward, along the inner wall of the orbit, from which it is separated by a layer of fat. Its short and thin tendon is attached to the part of the circumference of the sclerotica.

It is the shortest of the four recti muscles, but it is thicker than the superior and inferior.

It draws the eye inward.

II. OBLIQUE MUSCLES.

§ 2015. The *oblique muscles of the eye* (*M. obliqui bulbi oculi*) are distinguished into *superior* and *inferior*. They turn the globe of the eye on its longitudinal axis in opposite directions.

I. OBLIQUUS SUPERIOR.

§ 2016. The *obliquus superior* muscle, *grand oblique*, Ch. (*M. oculi obliquus superior, s. longus, s. trochlearis, patheticus*), arises from

the posterior part of the inner face of the internal wall of the orbit, before the optic foramen, and also arises from the sheath of the optic nerve by a thin and short tendon. Thence it goes upward and forward along the upper edge of the internal wall of the orbit, and becomes near its anterior extremity, a long rounded tendon.

This tendon immediately enters into a small cartilaginous layer about two lines long and broad, which is reflected on itself, and thus represents a semicanal, open upward, forward, and backward, and forms a pulley, the anterior edge of which becomes a pointed prominence, while the upper edges are attached by ligamentous fibres to the upper part of the internal wall of the orbit.

The tendon is kept in this pulley by a loose and moveable cellular tissue. Its direction changes, so that on emerging it descends from before backward, and from within outward. It then becomes broader, and is attached to the inner and upper part of the sclerotica, on the inside of the tendon of the rectus superior muscle which partially covers it.

This muscle is the longest and thinnest muscle of the eye.

It draws the eye forward, inward, and upward.

Sometimes, but rarely, it is more or less perfectly double.

II. OBLIQUUS INFERIOR.

§ 2017. The *obliquus inferior* muscle, *petit oblique*, Ch. (*M. oculi obliquus inferior*), the shortest muscle of the eye, differs from the other muscles in its origin and direction. It arises by a short tendon from the inner extremity of the lower edge of the orbit, goes upward and outward, then becomes a short and broad tendon, which ascends below the anterior part of the rectus externus muscle, and between the muscle and the globe of the eye, and is attached to the sclerotica, some distance behind the tendons of the recti muscles, between that of the externus and that of the superior.

It rotates the eye on its axis, first outward, then downward, and finally inward. It also draws the eye a little forward.

ARTICLE FOURTH.

FUNCTIONS OF THE EYE.

§ 2018. The eye represents an optical instrument,* composed of several transparent substances situated successively from without inward, which differ in density, although in all, this is greater than

* G. G. Ploucquet, *Diss. sistens momenta quædam physiologica circa visum*, Tubingen, 1797.—J. Campbell, in Thomson, *Annals of philosophy*, vol. x. p. 17–29.—Dunglison, *ibid.*, no. 60. p. 432.—T. Young, *Of the mechanism of the eye*, in the *Phil. trans.*, 1801, p. 81.—E. Hall, in the *Journal of sciences and the arts*, no. x. p. 249—257.—A. Horn, *The seat of vision determined*, London, 1815.—M. T. Muhlibach, *Inquisitio de visus, sensu*, Vienna, 1816.—J. Purkinje, *Beytrage zur Kenntniss des Sehens in subjektiver Hinsicht*, Prague, 1819. Troxlor, in Himly, *Ophthal*

that of the atmosphere. The rays of light which enter it gradually converge on passing through it, so as to form but one fasciculus, which paints the image of the object at the bottom of the eye on the retina. The impression upon this membrane extends to the brain along the optic nerve, and there produces the sensation of sight.

The transparency of the centres which form the eye, the sensibility of the retina, and the conducting power in the optic nerve, are then the principal conditions necessary to sight. The opacity of one or several of the centres which concur to form the eye, the paralysis of the retina and of the optic nerve, the alterations in the texture of all these parts, the abnormal productions which are developed within or around them, consequently alter or destroy the sense of vision. The globular form of the eye favours the refraction of rays of light. Hence, why the general form of the eye and of its different parts very much influence the distance at which objects are seen clearly. When the eye is very convex, the rays of light are forcibly refracted, and we cannot discern objects which are near (*myopia*). When the eye is flattened the refraction is less, and only distant objects are seen clearly (*presbytia, presbyopia*). Hence, why myopia belongs only to youth and infancy, and presbytia to old age. The eye possesses also the power of modifying its form, the relations of its constituent parts, its situation, and its direction, either to obtain a distinct view of objects situated at different distances, in a ray of a certain breadth, or to see without moving the head or body, those which occupy the different points of a portion of a surrounding sphere. This last effect is produced by the action of the six muscles of the eye. The other depends on the contraction of the muscles, partly on the modifications in the secretion and excretion of the humours of the eye, partly on the action of the ciliary body, since these three causes united change the curve of the transparent cornea and the crystalline lens, as also the situation of this latter in regard to the cornea and the base of the eye.* The dark colour of the pigment tempers the violence of the impression which the light would otherwise cause on the retina, which is extremely sensible,† for

Bibl., vol. i., p. 21—99.—Meyer, *Das Auge, ein Hohlspiegel*; in *Deutsches Archiv für die Physiologie*, vol. v., p. 154.—M. G. Plagge, *Neue physikalische Ansicht des Sehens*: *ibid.*, vol. v., p. 97.—Id. *Neuer Beytrag zur Lehre von Sehen*: ibid., vol. vii., p. 213.—E. E. Rœdenbeck, *Quædam ad theoriam visus pertinentia*, Berlin, 1822.

* Simonoff has concluded from calculations, that it is not necessary to suppose the crystalline lens displaced, and that the clearness of vision of objects situated from two hundred and fifty millimetres to any distance, however great, depends only on their apparent diameters, and on the transparency of the air between. (*Réfutation de la prétendue nécessité mathématique du déplacement du cristallin pour conserver constante la distance focale de l'œil*: in the *Journ. de physiol. expérim.*, vol. iv., p. 260. F. T.

† The sensibility of the retina is extreme only in regard to light. Magendie has determined that but a slight sensation is produced when this membrane is touched by a needle, and that even on scraping it, the pain is but slight, and not to be compared with that caused by pricking the surface of the eye. (*De l'influence de la cinquième paire sur la nutrition et les fonctions de l'œil*: in the *Journ. de phys. expér.*, vol, iv., p. 176.) This physiologist has also determined that the section of the two nerves of the fifth pair causes the loss of sight. F. T.

this black layer absorbs a part of the rays of light. This is the real function of the pigment, since vision is weak and imperfect when it has not its usual colour. The iris also serves to moderate the intensity of the light which enters the eye, since this membrane dilates, and thus contracts the pupil, when the light is very vivid, or when we look at an object near, while it contracts and thus enlarges the pupil, when the light is weak, or when we look at rather a distant object.

ARTICLE FIFTH.

DIFFERENCES IN THE EYE DEPENDING ON DEVELOPMENT.

§ 2019. The eye differs considerably at different periods of life* in respect to the existence, proportional volume, and form of the whole eye or of its parts.

The eye appears very early. It is visible at the fourth week of pregnancy as a black spot.

But at this period the globe of the eye is still exposed, for the eyelids do not exist. They begin to appear during the tenth week, in the form of narrow bursæ, which gradually enlarge. After about the twelfth week their edges touch, and they remain closed as in sleep, until birth.

The lachrymal puncta, and generally all the lachrymal apparatus, as also the Meibomian glands, are proportionally more developed during the early periods of life than subsequently.

The eye is proportionally larger in the early periods of life than afterward. The two external membranes, the sclerotica, especially its posterior part, and the transparent cornea, are proportionally thicker. This character belongs especially to the cornea, which is twice as thick as it is in the adult, from a considerable quantity of reddish serum existing between its layers, in the full grown fœtus, so that its anterior face is nearly plane, and the posterior touches the iris. It is also less transparent than subsequently. In old age it becomes planer, harder, denser, and more solid: we also see developed, in old men, a nebulum, which extends from the edge to the centre (*gerontotoxon*, s. *arcus senilis*), which undoubtedly depends on the slowness with which the substance is renewed, whence the fluids have more tendency to coagulate; this resembles those ossifications which supervene in old age in other parts of the body.

The choroid membrane also is proportionally thicker, and the black pigment which covers it has a deeper tint.

The pigment begins to appear very early at the fifth month of pregnancy. But before birth it is less coloured than in the adult: it adheres less to the choroid membrane and the iris: it does not exist on the outer face of the first of these two membranes, so that the intensity of its

* J. G. Brendel, *De fabrica oculi in fœtibus abortivis observata*, Gottingen, 1752

colour and even its quantity seems to depend on the action of the light. In subjects at an advanced age, its colour changes like the hair, and it is lighter, but the cornea and crystalline lens loose their transparency in the same proportion. The deeper colour of the pigment in youth, depends partly on the fact, that the globules are nearer each other, partly also on their being blacker at this period. They are also softer in young people, and hence they loose their from, and are detached from each other by drying. In the full grown fœtus, the white cellular tissue existing between the vessels of the choroid membrane, contains no iron, while there is much in that coloured black found in the same place in the adult.*

The iris is one of the parts of the eye which varies the most at different periods; the greatest change is the closing of the pupil by the pupillary membrane (*membrana pupillaris*), or the *membrane of Wachendorff*, in honor of its discoverer.†

The external edge of this membrane arises from the inner edge of the iris. It fills the whole pupil, so as to separate completely the posterior from the anterior chamber. It is a very tense, rather solid, but very delicate, thin, and transparent membrane, so that when its blood vessels are injected, they cannot be perceived until the eye is hardened by immersion in alcohol. It is composed of two layers, the anterior of which is a continuation of the serous membrane which lines the anterior face of the iris; and the posterior is very vascular, and is continuous with the posterior face of the iris. We have never known it to be covered posteriorly with a fibrous mucus, as Haller and Wachendorff assert.

Some of its arteries arise:

1st. From those which form the inner circle of the iris: they radiate from this circle towards the centre of the pupillary membrane, where anastomosing with the adjacent vessels, and not with those opposite, they terminate and leave a small space in the centre of the membrane. They also anastomose with each other frequently in their course.

2d. Other branches arise directly from the long ciliary arteries, pass on the iris and go directly to the pupillary membrane, where they anastomose with the preceding.

3d. Others still smaller arise from the vessels of the anterior face and from the greater edge of the crystalline lens, and are distributed principally on the posterior face of the pupillary membrane.

* Coli, in Mondini, *loc. cit.* p. 17.

† E. J. Wachendorff, in *Comm. Nor*, 1740. Hebd. 18., p. 137.—Haller, *De nova tunica pupillam fœtus claudenti*; in the *Act. Upsal.*, 1742, and *Op. min.*, vol. i., p. 329.—J. G. Rœderer, *De fœtu perfecto*, Strasburg, 1750, § xxvi.—B. S. Albinus, *De membrana pupillam infantis nuper nati præcludente*: in *Annot., acad.* l. i., cap. vii.—Vicq-d'Azyr, *Sur la membrane pupillaire du fœtus*: in *Hist. de la soc. roy. de Méd.*, ann. 1777 and 1778, p. 257.—J. F. Blumenbach, *De oculis leucæthiopum et motu iridis*, Gottingen, 1786.—H. A. Wrisberg, *De membrana fœtus pupillari*: in *Nov. comm. Gott.*, vol. ii., and in *Syllog. comm.* I.—Edwards, *Sur la structure de l'œil*: in the *Bull. de la soc. philomatique*, 1814, p. 21.—J. Cloquet, *Mémoire sur la membrane pupillaire et sur la formation du petit cercle artériel de l'iris*, Paris, 1818.—Portal, *Sur la membrane pupillaire*: in *Mémoires du Muscum*, vol. iv., p. 457.

Veins have not been demonstrated with certainty on the posterior face of the pupillary membrane.

The pupillary membrane passes through several periods of devlopment. Its primitive form is not known, nor the manner in which it is produced, nor the period of its first appearance.

According to Wrisberg it is not perceived distinctly before the third month of pregnancy. It is gelatinous and destitute of vessels until the fifth month, but at this period it becomes firmer and vessels are developed in it. Perhaps, however, in the early periods of life it is greater in proportion to the rest of the iris, for the development of the latter membrane begins at its external edge.

It is most evident at the seventh month of pregnancy. It begins to disappear at the eighth month from the centre to the edge, that is, from the portion which has no vessels. In the full-grown fœtus the only vestiges of this membrane are some small loose flocculæ attached to the edge of the pupil.

It generally disappears much sooner in animals born with the faculty of seeing than in those born blind; it continues in these latter also as long as the eyelids remain closed.* The vessels are not destroyed with it. They contract from the centre toward the circumference; their arches diminish and they are finally adapted to the inner edge of the iris, where they form the small arterial circle, which does not exist so long as the pupillary membrane continues.†

Although this membrane perfectly separates the two chambers, each cavity constantly incloses an aqueous humour, which does not exist in the posterior alone as Edwards ‡ and Ribes § assert. We have demonstrated this perfectly.|| and Cloquet after us.¶

A very curious periodical difference of the iris is a want of continuity of its circle, which is observed during the early periods of pregnancy, and which is very sensible at its inner part until about the seventh week.

The retina is much thicker in the early periods of life than afterward. This thickness does not depend on the greater development of its inner layer; and so far from the medullary layer being proportionally thinner at this period, so far from possessing at that time less medullary matter, as has been asserted,** this substance on the contrary is more abundant, and hence the increase of

* Meckel, *Ueber die Dauer der pupillar Membran*; in the *Deutsches Archiv. für die Physiologie*, vol. i., p. 430; vol. ii., p. 136.

† In demonstrating this fact, J. Cloquet has verified a conjecture of Blumenbach: *Ejusque (membranæ pupillaris) vasorum elliptici arcus sensim sensimque retrahuntur, tuncque, ni graviter fallor, annulum iridis interiorem efficient, cujus certe ante eum terminum nullum in fœtuum oculis vestigium reperire potui.* (*Inst. physiol.*, 1787, p. 208.)

‡ *Loc. cit.*

§ *Loc. cit.*

|| *Loc. cit.*

¶ *Loc. cit.*

** Brandis, *Pathologie*, Hamburgh, 1808, p. 241.

thickness presented by the membrane. In old men the retina becomes extremely thin, but also more firm and resisting.

We already perceive its fold in the sixth month of pregnancy, and even in the full-grown fœtus it is greater than in the adult. The thin place is visible, but the yellow tint does not appear till some time after birth. It gradually becomes more intense, but turns paler as age advances. It would seem that the fold diminished regularly and finally disappeared entirely. The less marked development in this region in old men is about in a direct ratio with the loss of transparency, which gradually takes place in the cornea. The aqueous humour is turbid in the fœtus. It becomes perfectly transparent during the first few weeks after birth.

The crystalline lens also is much more convex in the fœtus and in infancy than in the adult. At first it projects through the pupil, and thus pushes the iris before it, so that it is separated from the transparent cornea only by this membrane being situated in its special groove. In this respect,and in the absence of the eyelids, the eye of the fœtus resembles that of fishes.

This arrangement, added to the great thickness of the transparent cornea, causes the chambers to be smaller and the aqueous humour less abundant than in the adult. All the humours, however, excepting the aqueous, are more abundant in youth than subsequently, whence it follows that the whole eye, and particularly the cornea, projects more, while as age advances, the eye slightly collapses and the transparent cornea particularly flattens.

As age advances the crystalline lens assumes more consistence, and also becomes yellowish on leaving the centre, so that this tint is found generally in persons in advanced life. The same is true of the humour of Morgagni. At the same time this humour and that which fills the two chambers are slightly turbid, which is sometimes the case also with the vitreous humour.

ARTICLE SIXTH.

EYE IN THE ABNORMAL STATE.

§ 2020. The situation of the eye exposing it to the action of all external causes of injury, and its extreme sensibility rendering it liable to be diseased from the influence of these causes, or to participate in the affections of other parts of the body, and finally its very complex structure, singularly multiply the number of the anomalies it may present; these anomalies are more easilyperceived even during

life than in most other organs, on account of its situation and the transparency of its parts.*

I. DEVIATIONS OF FORMATION.

§ 2021. Here, as in other organs of the body, the primitive deviations of formation are the most remarkable in respect to the consequences deduced from them in regard to the general theory of organization.

A. PRIMITIVE DEVIATIONS OF FORMATION.

§ 2022. I. The primitive deviations of formation in respect to quantity consists essentially in too slight an action of the formative power. They are:

1st. Deviations in formation from defect in development. Here we may mention:

a. The *absence* of the eye or of some of its parts. Here, as in the other organs, the conditions are not always exactly the same. In one case observed by Malacarne,† the optic beds and nerves, the common and the superior motor nerves, the globe of the eye, its muscles, the caruncula lachrymalis, and the optic foramina, were all deficient. The globe of the eye was replaced by a hard mass. The lachrymal apparatus and the eyelids were perfectly developed.

In another case‡ the globe of the eye and the optic nerve as far as its bed and the optic foramen were deficient, but the accessory nerves and the lachrymal gland were present.

b. Smallness of the organ.

* Beside the treatises on the diseases of the eyes, among which we may mention particularly those of Maître Jean, Taylor, Janin, Rowley, Beer, Scarpa, Schmidt, and Himly, beside also the works already mentioned, because their authors have examined it both in the state of health and that of disease, we shall mention, on the pathological anatomy of this organ, the following: J. C. Sybel, *Diss. de quibusdam materiæ et formæ oculi aberrationibus a statu normali*, Halle, 1798.—J. Wardrop, *Essays on the morbid anatomy of the human eye*, London, 1818.—Farre, *A treatise on some practical points relating to the diseases of the eye, by the late Cunningham Saunders, to which are added, &c.*, London, 1816.—Demours, *Traité des maladies des yeux*, Paris, 1818.—Helling, *Praktisches Handbuch der Augenkrankheiten*, Berlin, 1721.—Baratta, *Osservazioni practiche sulle principali malattie degli occhi*, Milan, 1821.—L. M. Mejra, *Tratado teorico y practico sobre las infermidades de los ojos*, Orea, 1820.—B. Travers, *Synopsis of the diseases of the eye*, London, 1820.—J. Vetch, *A practical treatise on the diseases of the eye*, London, 1820.—Consult also, on the pathological anatomy of the lachrymal organ, J. A. Schmidt, *Ueber die Krankheiten des Thranenorgans*, Vienna, 1803.—J. H. Tode, *Des maladies de la glande lacrymale*; in the *Mélanges de chirurgie étrangère*, Geneva, 1824, p. 391.

† *Isistemi*, Padua, 1803.

‡ Weidele, in Himly, *Ophthalmolog. Bibliothek.*, vol. iii., p. 2, p. 170.

c. The abnormal continuance of parts primarily existing, particularly of the pupillary membrane.*

d. The adhesion of the two eyes. It is rather a general law in this case that the eye formed by the fusion of the two in one is situated directly on the median line, and is symmetrical in its structure.

2d. Deviations in formation, or in regard to quantity in an opposite sense when the body and head are normal, are very rare, and perhaps have never been observed.

II. The deviations of formation in respect to quality are also rare. They affect most frequently the form of the iris and that of the pupil, which then is usually less round and most commonly perpendicular, rarely horizontal. This anomaly, often peculiar to certain families, and hereditary, is always curious as an analogy with animals.† The iris is rarely enlarged so much outward that the pupil does not correspond to the axis of the eye, being carried much more inward.‡

The transparent cornea is sometimes conical (*staphyloma conoides*), and at the same time it is more or less thin. This state is its greatest degree of convexity, whence this includes also the greatest degree of myopia.

Sometimes the cornea presents an opposite arrangement, being not sufficiently convex or entirely plane.

B. ACCIDENTAL DEVIATIONS OF FORMATION.

§ 2023. The *accidental deviations of formation* are more common than the preceding and very various, but they depend most generally on a prevous alteration in the chemical composition, and the texture of the parts is then more or less changed. The principal deviations of this kind are:

1st. *Absence*. Here we may mention the loss of the eyelashes and eyebrows, caused by the destruction of their bulbs, by inflammations and ulcerations of the eyelids.

2d. *Alterations in size.*

a. *Smallnes*. In blindness, the whole eye or at least some of its parts, particularly the optic nerve and the retina, are often wasted.

We have found several times in subjects who have been blind for a long time, that the retina was unusually thin and destitute of medullary substance in several parts of its extent, this substance existing at intervals.

When the power of vision is more or less diminished, the yellow spot also returns to the degree of colour it presented before the eye was exposed to the light, for in this case its tint is more or less

* See our *Handbuch der pathologischen Anatomie*, vol. i., p. 396.
† See our *Handbuch der pathologischen Anatomie*, vol. ii p. 158
‡ Demours, tab. lxiv., fig. 1.

feeled. At the same time the fold is more or less effaced.* Sometimes subjects affected with amaurosis the retina presents in this place ack spots;† but only the diseased eye undergoes this change; the .d and the spot are on the contrary sometimes more sensible in that the healthy side;‡ the optic nerve is even sometimes larger than the normal state.§

The optic nerve is generally thinner and grey like horn.

The transparent cornea sometimes becomes much flatter after dis-ses of long duration and excessive evacuations.

The crystalline lens, left in the eye after separating it from its cap-le, partially or wholly disappears very rapidly. At the end of a v years there is hardly a piece as large as a pin-head.||

b. *Enlargement.* The eye somtimes enlarges so much from dropsy *ydrophthalmus*) that it projects on the outside of the orbit. This opsy is situated primitively in the vitreous body; but it extends to ery part, so that in some subjects we find considerable serum be-een the crystalline lens and the vitreous body.¶ Scarpa states it dropsy of the posterior part of the eye is usually attended with an creased secretion out of the vitreous body, as we have found several nes on the inside of the choroid membrane and of the retina a great antity of limpid serum, in which is a cord directed from before ckward, formed by the morbid alteration of the vitreous body and ina.** In this case probably the serum came from the serous embrane discovered by Jacob.

A partial enlargement of the eye, often met with, forms *staphy-ia*,†† a greater or less thickening of the transparent cornea, which uses the falling of this membrane, attended with its opacity, and pends on a previous inflammation situated in it. In this case the rnea generally adheres to the iris. The increase with the thinness the sclerotica, which is much rarer and is also termed *staphyloma*, pears under the form of bluish elevations, the colour of which de-nds on the varicose state of the vessels of the choroid membrane. supervenes principally on the circumference of the transparent rnea after arthritic ophthalmia, but is observed more rarely at the sterior part of the sclerotica.‡‡

The lachrymal sac is more or less distended after inflammation of e lachrymal passages.

3d. *Solutions of continuity.*

* Michaelis, *loc. cit.*, p. 8.—Reil, *loc. cit.*, p. 472.—Léveillé, in Wenzel, *De it struct. cereb.*, p. 167.
† Wenzel, in Michaelis, *loc. cit.*, p. 9.
‡ Michaelis, *loc. cit.*, p. 3.
§ Wenzel, *De pen. struct. cereb.*, no. xi.
|| Scarpa, *Malattie degli occhi*, Pavia, 1801, p. 183.
¶ Ribes, *loc. cit.*
** *Malattie degli occhi*, p. 230.
†† J. L. Friedrich, *Diss. de staphylomate*, Berlin, 1821.
‡‡ *Loc. cit.*, tab. ii., fig. 10.—Demours, *loc. cit.*, tab. lxiv., fig. 3.

a. Abnormal union. This anomaly is rather common, and always results from inflammation.

When the conjunctiva has been violently inflamed and neglected, the eyelids join either to the anterior face of the eye (*symblepharon*), or with each other (*ancyloblepharon*). Sometimes these two kinds of adhesion take place simultaneously. The parts fused are sometimes nearer each other, and are often united by a greater or less number of accidental membranes which vary in length. Sometimes they adhere at birth.

After inflammations of the iris, the pupil adheres (*synizesis*), or the anterior face of the iris unites to the posterior face of the transparent cornea, or finally the posterior to the anterior face of the crystalline capsule (*synechia*), by an effusion of albumen which coagulates, and which is sometimes distinct from the other parts in the form of a membrane.

The obliteration of the ducts of the lachrymal gland is caused by external lesions on the outside of the eye. It depends on inflammation and ulceration, like the contractions of the excretory channels of the lachrymal humour.

The shrinking (*myosis*) and the immobility of the pupil, observed after inflammations of the eye, very probably result from an effusion of albumen into its substance.

b. Abnormal separation. The parts of the eye rarely present this anomaly except from external injuries. We however must arrange here the detachment of the crystalline lens observed after violent cephalagia and the fall of this lens into the anterior chamber across the pupil, which results from the percussion or commotion of the eye.*

Ulcers produce especially in the transparent cornea, sometimes also in the iris, solutions of continuity, which, when situated in the first of these two membranes, cause the effusion of the aqueous humour and the falling of the iris. The iris is frequently detached in a greater or less extent from the sclerotica by a powerful shock: two pupils might then be said to exist. We must refer also to this head the abnormal enlargement of the openings, for instance, the pupil (*mydriasis*).

Ruptures and other lesions of one or more excretory passages of the lachrymal gland form the *lachrymal tumor* (*dacryops*), the accumulation of tears between the conjunctiva and the globe of the eye, or a too great effusion of this fluid.

Suppuration of the lachrymal sac frequently destroys a portion of it and its communication with the exterior, and thus produces *fistula lachrymalis.*

4th. *Deviations in situation.* These anomalies extend to the whole eye, or affect some of its constituent parts only. The globe of the eye may be pushed out of the orbit by tumours in its cavity (*exophthalmia*), and may fall forward from the injury or the paralysis of its

* Fribault, *Observation sur un cristallin qui a passé par le pupille dans la chambre antérieure de l'œil;* in the *Journ. de méd.* vol. lix., p. 72.

nuscles (*ophthalmoptosis*), which changes more or less the situation of the eyelids, and causes them to turn over outward.

The direction of the eyelids alone is frequently changed, which may take place in two different modes, according as they are turned outward (*ectropium*) or inward (*entropium*). The latter effect is produced particularly by the destruction of the internal layer of the skin of the lid and the cartilage, after inflammation of the eyelids, by a dropsical state of these parts, sometimes by the paralysis of the levator palpebræ muscle. This paralysis however is never sufficient to cause it alone, it producing only the fall of the upper eyelid (*blepharoptosis*). The first state is caused principally by wounds in the skin with loss of substance, sometimes also by the development of tumours and excrescences on its inner face.

When the lid is turned inward, the eyelashes naturally touch the globe of the eye. Hence it is called *trichiasis*, in which only some lashes participate, which occurs after inflammation of the eyelids, and arises from the inner part of the edge of the eyelids being destroyed by ulcerations.

The prolapsus of the iris occurs in wounds of the transparent cornea, and when this latter membrance presents several openings through which the iris protrudes, a kind of staphyloma occurs which is termed the *bunch of grapes*. At first the protruded portion of the iris is exposed, soft, thin, and very vascular; it gradually becomes solid, the circulation stops, and it is covered by a thin, greyish white membrane, which Beer regards as the regenerated conjunctiva;* but it is more correct to consider it a new production formed by the exudation of the lymph from the iris.

The protrusion of the membrane of the aqueous humour, admitted by most writers, is a prolapsus of the vitreous body, as Scarpa has perfectly demonstrated.†

II. ALTERATIONS IN COMPOSITION AND TEXTURE.

§ 2024. Almost all the alterations of composition and texture in the eye, as in other parts of the body, depend on inflammation, to which this organ is very much exposed. Several of them however are developed, and we cannot consider them as resulting exactly from previous inflammation.

Alterations in texture are very rarely congenital. We must, however, regard as such the anomalies in the colour of the eye, which may be referred: 1st, to a want of colour in the pigment (*leucæthiopia*); 2d, the different colours of the iris in the two eyes, or even in its different

* *Augenkrankheiten*, vol. ii. p. 63.
† *Loc., cit.* p. 170.

parts in the same eye; 3d, to a want of transparency. Farar also * has observed in three children of the same family, that the cornea at the moment of birth was clouded by a nebulosity, which afterwards gradually disappeared from the outside towards the centre.

The new formations which must always, or at least in most cases, be considered as consequences of inflammation, are principally the following:

1st. In the *eyelids.*

a. Grando, a rounded tumour, which varies in hardness and is developed on or little below the lower edge. It is a purulent cyst, a *stye* (*hordeolum*), not entirely destroyed by suppuration, and which is filled with coagulated albumen.

b. Sarcoma of the eyelid, which is red, and at first soft, afterwards harder, and which is developed on the inner face of the eyelids, particularly in lymphatic subjects.

Here we may mention the *encanthis*, a tumour situated in the caruncula lachrymalis and the third eyelid.

2d. *In the conjunctiva.* The *film* is a greater or less elevation which is developed between the anterior face of the sclerotica and the conjunctiva which covers it. The (*pterygium*) † commonly arises in the inner angle of the eye, where it extends outward to the anterior face of the transparent cornea, and beyond the centre of this latter. We rarely find a second or even a third in the external angle of the eye or in another region. It is more or less vascular, and its base always looks toward the circumference and its summit towards the centre of the eye, undoubtedly because the connection of the conjunctiva with the subjacent membrane is less intimate in the first place than in the second, where in fact it blends with the transparent cornea.

The *pannus* differs from the pterygium as it is the substance of the conjunctiva, and sometimes also that of the transparent cornea, which thickens. The tumour termed *pinguecula* is generally developed in the external angle of the eye, or at least on the outside of the cornea. It is seldom larger than a bean, and it is formed by the conjunctiva and the subjacent cellular tissue.

3d. *In the transparent cornea* ‡ the principal results of inflammation are *maculæ* and *nebulæ* (*obscuratio, albugo*, s. *leucoma*), which sometimes arise only from simple exudations in the tissue of the cornea, sometimes also are cicatrices of ulcers of this membrane, and vary in their extent and their degree of opacity. In the first case, the surface of the cornea does not differ at the spot where the point is from

* *Med. communic.*, vol. ii., p. 463.

† Beer (*loc. cit.*, vol. ii. p. 638) does not consider the pterygium as resulting from an inflammation. We may however mention in support of this not only his own opinion that the tumour usually appears when caustics are applied (p. 610), but also Larrey's observations, who remarked that it frequently was a consequent of the Egyptian ophthalmia.

‡ G. Miarult, *Mémoire sur la kératite ou inaflmmation de la cornée transparente*; in the *Arch. gén. de méd.*, vol. iii., p. 5.

other parts; in the second it is deep. The cicatrix is always hard, like the spot produced by an old exudation. Farther we observe no other alteration of texture in the place where it is situated.*

4th. *In the iris* the pupil is effaced (*atresia pupillæ*) by an opaque false membrane, which causes at the same time the adhesion of the posterior face of the iris to the crystalline (*synechia*) capsule. Then the production of pus or of a puriform fluid on the surface of the iris, whence a puriform congestion is formed in the chamber of the eye, which is termed *hypopon*. Scarpa thinks that it is real pus which forms here, since we do not find in the iris an abscess the rupture of which could produce this purulent humour.† The serous nature of the two faces of the iris favors his opinion, but the authority of Beer‡ at least authorises us to doubt it as a general rule.

5th. *In the crystalline lens and its capsule*, which are frequently the seat of *cataract* (*cataracta*, s. *suffusio*), which most generally renders opaque parts normally transparent.

Cataract varies in situation, consistence, and colour. It usually arises from opacity of the crystalline lens (*C. cristallina*, *C. lenticularis*), more rarely of the crystalline capsule, especially of its posterior face (*C. capsulaire*, *C. capsularis*), still more rarely in the humour of Morgagni (*C. laiteuse*, *C. Morgagniana*, s. *lactea*). These three kinds co-exist in the *capsulo-crystalline cataract* (*C. capsulo-lenticularis*.

Opacity generally commences in the centre§ and very deeply in the crystalline cataract, and on the contrary in the margin in the capsular cataract. Sometimes in the latter case only some parts are opaque, forming the *dotted* or *mottled* cataract (*C. fenestrata*). Most generally, but not always in old men, the crystalline lens is unusually hard, and in a measure ossified or petrified (*C. dura*). It is rarely softer than in the normal state (*C. mollis*), or even fluid (*C. fluida*). The capsule is more frequently hardened and thickened. Its anterior face is also covered in some cases (*C. trabiculata, pyramidata*) by a layer of substance, sometimes having the consistence of osseous tissue,‖ which arises from an exudation formed by the inflamed iris, and which consequently can always be separated to a certain extent from the capsule.¶ The colour of the cataract is most generally greyish white.

In the crystalline and the capsular cataract, the crystalline lens and its capsule are not unfrequently detached from each other, or from the adjacent parts, by a shock of the body. But they are sometimes connected more intimately, and so extensively that the crystalline capsule and the iris adhere.

* Wardrop, *Loc. cit.*, p. 93.
† *Loc. cit.*, p. 149.
‡ *Loc. cit.*, vol. i., p. 436.
§ Rudolphi (*Grundriss der Physiologie*, vol. ii., p. 184) mentions a family in Berlin in which the *central* cataract (*C. centralis*) is hereditary; this consists in a single dark point in the centre of the crystalline lens, which remains stationary.
‖ Beer, *loc. cit.*, p. 303.
¶ Beer, *loc. cit.*, p. 297.

In the pyramidal cataract the thick anterior wall of the capsule sometimes projects through the pupil and advances to the transparent cornea, to which it sometimes adheres.

6th. In the *vitreous* body, the loss of transparency (*glaucoma*) and the complete dissolution of it (*synchysis*), which usually attend gutta serena.*

§ 2025. The new formations developed in the eye are probably caused by an action similar to inflammation; we cannot, however, always consider them as resulting positively from this cause. They are divided as in every other part, into those which are abnormal only from the place where they are developed, and those which are entirely new.

1st. Among the tissues normally existing in other parts of the body we distinguish:

a. The cellular tissue, which, assuming the form of false membranes, unites parts which are primitively separate, and which we have already mentioned in this respect as produced by inflammation.

b. The vascular tissue, which arises in the same manner in the different new formations, especially in the preceding.

c The serous tissue, which is developed in the eyelids, especially the superior, in the form of cysts within the lachrymal gland in the orbit,† more rarely between the choroid coat and the retina.‡ We probably can arrange here the cysts formed on the surface of the iris when this membrane projects through an opening in the transparent cornea.

d. The fibrous tissue, which occurs much more rarely. In one case the retina was changed into a white, fibrous, and very solid membrane, exactly similar to an aponeurosis, the external face of which adhered very intimately to an osseous layer between it and the choroid membrane.§

e. The osseous tissue, which generally appears in the form of more or less irregular thin layers between the choroid coat and the retina, probably from the change of the serous membrane which covers the outer part of the choroid coat. It is seen more rarely in the transparent cornea,‖ and it is probably developed primitively in the membrane of Descemet.

We must probably mention here the considerable and petrous hardening of the opaque crystalline lens and the formation of stony concretions in the place of the vitreous body; for the latter concretions, even when they become considerably thick, do not result from the change of the vitreous body, but from between the choroid membrane and the

* Heister, in the *Act. nat. cur.*, vol. i., p. 71.—Demours, *loc. cit.*, vol. i., p. 390.
† Beer, *loc. cit.*, vol. ii., p. 589, *note*.
‡ Portal, *Anat. méd.*, vol. iv., p. 418.
§ Magendie, in Demours, *loc. cit.*, 73, vol. i.
‖ Walter, *Anat. mus.*, vol. i., p. 139.—Wardrop, *loc. cit.*, p. 72.—Anderson, *ibid.*, p. 73.

·etina, and only push this body outward, since it is crowded and vasted in their centre.*

f. Among the constituent parts of the cutaneous tissue the hairs ıre probably the only ones abnormally developed in the eye, unless ve refer to it those cysts which form around hernias of the iris, and vhich we have referred to the serous system. The conjunctiva seems o be the only part of the eye where the hairs take root. They some imes appear also as abnormal eyelashes (*distichiasis*) on the inner dge of the upper eyelid after neglected ophthalmias, and differ from he common lashes in their situation, thinness, smallness, and whitish olour.† They are rarely developed in the conjunctiva of the eye, ·here they appear either in the conjunctiva itself, which is most sual,‡ or on the transparent cornea.§ In the cases observed by limly they were inserted in the centre of a fatty production, and in ll other cases, at least those detailed by Wardrop, and Demours, a terygium or film was the base of them, that is, they were preceded y a morbid change. Himly and Wardrop have observed this forma- on in the external, and Demours in the internal angle of the eye. 'his latter case consequently resembles the considerable increase of ne of the hairs of the caruncula lachrymalis, seen by Albinus.‖ It curious that in the few cases of this anomaly as yet published, there an evident connection between the period of puberty and the deve- ›pment of accidental hairs. In the cases described by Wardrop, the ıirs did not appear till the age of sixteen years with the beard, and that described by Himly the tumor appeared at the age of two ·ars, but did not become troublesome till the age of twenty, doubt- ss because hairs were not developed upon its surface.

2d. The entirely new formations are:

a. Figlike excrescences which appear in the iris, from syphilitic flammation.

b. Fungus hematodes, which is developed sometimes in the eye ·elf, and as it would seem on the posterior part of the choroid mem- ane, whence it goes forward, destroying before it all parts of the gan, and often extends to the outside of the eye in the fat of the bit. Perhaps we ought also to arrange here the excrescences which e developed within the optic nerve.¶

c. The entozoaries. To these may probably be referred, at least metimes, the loose hydatids which appear in the lachrymal gland, d which are explained better in the manner than by attributing

* Scarpa, p. 269.
† Beer, *loc. cit.*, p. 119.
‡ Himly, *Ophthalm. Bibl.*, vol. ii., part i., p. 199.—Ware, *On entropion*, p. 7.— ırdrop, p. 31.—Demours, tab. lxiv., fig. 1.
§ Gazelles, in the *Journ. de méd.*, vol. xxiv,
‖ *Annot. acad.*, book iii., cap. viii.
¶ Gallereux, in Demours, vol. i., p. 75.

them to change of the cellular tissue.* The filaria Medinensis sometimes occurs below the conjunctiva.†

CHAPTER III.

ORGAN OF SMELL.

§ 2026. The senses of hearing and sight, the organs of which have been described, differ from the others in respect to their relations with other organs, as they are more independent. Those of smell and taste, on the contrary, are only portions of other organs, for they both belong to the digestive system, and the first also to the respiratory system. It would than be proper to consider the organs of smell, voice, and respiration, of taste, and of digestion, as forming a single system. It is impossible to separate the history of the tongue from that of the intestinal canal, since it is situated in a cavity, the commencement of the digestive apparatus, and in which the food is remarkably changed, since it is also situated behind the organs which cause these changes. But we shall consider the organ of smell separately, since it is more independent than that of taste, and after leaving the fishes it is entirely separated from the respiratory system, which in the three upper classes of animals communicates with the exterior, not only by the olfactory organ, but also by the oral cavity.

ARTICLE FIRST.

ORGAN OF SMELL IN THE PERFECT STATE.

§ 2027. The *organ of smell*, or the *nose*,‡ is composed:

1st. Of a bony cavity divided into several compartments, the upper and posterior part of which is more extensive, and is formed by bones, whence it is termed the *bony nose* (*nasus osseus*), and has already been described in osteology.

2d. Of an anterior, smaller, triangular, elongated, and cartilaginous portion, the *cartilaginous portion* (*nasus cartilagineus*).

3d. Of muscles which move this cartilaginous portion.

* Schmidt, *Krankheiten des Thränenorgans*, p. 75.

† Larrey, *Mémoires et compagnes*, vol. i., p. 223.

‡ Santorini, *Observationes anatomicæ*, Venice, 1724, cap, v., *De naso*. p. 84.—Ziervogel (Aurivillius), *De naribus internus*, Upsal, 1760.—A. Scarpa, *Anatomicæ disquisitiones de auditu et olfactu*, Milan, 1795.—T. C. Rosenthal, *De organo olfactus quorundem animalium*, Gripswald, 1807.—S. T. Sœmmerring, *Abbildungen des menschlichen Organs des Geruchs*, Frankfort, 1809.

4th. Of a mucous membrane which covers the osseous and the cartilaginous nose.

5th. Of nerves which are distributed in this membrane.

In considering the nose externally we distinguish an upper part or the *root*, an anterior edge or the *back*, and a lower part or the *tip*.

I. CARTILAGINOUS NOSE.

§ 2028. The *cartilaginous nose*, the anterior extremity of the bony nose, is composed of a central and perpendicular portion, the *cartilaginous septum* of the nose (*septum narium cartilagineum*), of two *alæ pinnæ*, s. *alæ nasi*), finally of two oblong openings termed *nostrils* (*nares*), by which the cavity of the nose opens externally, and which are supplied, especially on their inside, with stiff hairs (*vibrissæ.*)

It is composed of several thin cartilages united with each other and with the bony portion of the nose, externally with the skin, internally with a mucous membrane. There are generally eleven.

The largest, the *cartilage of the septum*, is perpendicular and square. It completes the osseous septum anteriorly, where it is included between the perpendicular plate of the ethmoid bone, the vomer, and the median suture of the two proper nasal bones. Its anterior edge descends from before backward, is loose, and is attached to a long prolongation of the skin, the cutaneous septum of the nose.

The *superior lateral* cartilage is square and is attached to the lower edge of the proper nasal bone, to the ascending process of the superior maxillary bone, and to the upper edge of the preceding. It is generally blended with this latter so intimately that they form but one body.* Below this superior lateral cartilage, and at the side of the lower part of the median line, is the *inferior lateral* cartilage, or the *cartilage of the ala* (*C. pinnæ*), which is very low. This cartilage is narrow and formed of two pieces, an internal and an external, which unite forward at an acute angle, where they frequently present a foramen, and are sometimes entirely separated from each other. The external piece is longer and higher than the internal. Next come from before backward and from without inward several *square* cartilages; these are much smaller, diminish in extent from before backward, circumscribe the nostril backward and outward, and are often blended with each other and with the preceding. From two to five other still smaller *sesamoid* cartilages (*C. sesamoideæ*) are situated forward on each side, between that of the septum and the two lateral cartilages.

* Santorini, *loc. cit.*, p. 85.

II. MUSCLES OF THE NOSE.

§ 2029. The cartilaginous nose is moved by a great many muscles,* two of which belong to it exclusively and two are common with the adjacent parts.

A. LEVATOR ALÆ NASI LABIIQUE SUPERIORIS.

§ 2030. The *levator alæ nasi abiique superioris* or the *pyramidal* muscle, *grand sus-maxillo-labial*, Ch., arises from the nasal process of the upper maxillary bone, usually blends in this place with the frontalis muscle, descends in the side of the nose, and divides into two fasciculi, an anterior which is smaller, and is expanded in the lower lateral cartilage; the other is much larger, and blends with the orbicularis oris and the superior muscles of the upper lip. It raises the ala of the nose and the upper lip, and opens the nostril.

B. COMPRESSOR NARIUM.

§ 2031. The *compressor narium* muscle, *sus-maxillo-nasal*, Ch., is triangular, thick, and narrow at the base, and broad above. It ascends from the posterior part of the ala of the nose, where it is blended with the preceding, which partly covers it, and goes from behind forward toward the back of the nose, on which it unites with that of the opposite side without any intermediate tendon. It often gives off at the upper part, a prolongation which blends with the frontalis muscle. This is the *procerus* muscle of Santorini, the lower part of his *transversus nasi* muscle.

It contracts the nostrils when it acts from below upward, or from above downward, and never dilates them.

C. DEPRESSOR ALÆ NASI.

§ 2032. The *depressor alæ nasi* muscle, the *proper muscle of the ala* (*M. pinnarum*, s. *narium lateralis*, Santorini, s. *dilator narium proprius*, s. *inferior*), arises from the upper maxillary bone, above the canine tooth and the external incisor. It is formed of oblique fibres, and extends almost the whole length of the outside of the cartilage of the ala of the nose. Its principal effect is to dilate the nostril when the nose is at rest. Being inserted in the upper maxillary bone, it can depress the nose. Finally, as its external face is attached to the integuments of the upper lip, it can also depress this latter.

* Santorini, *Obs. anat.*, cap. i., *de musculis facici*, p. 11.—Id., *Tabulæ XVII.*, tab. i.—A. F. Walter, *Tener. musc. hum. corp. anat. repet.*, Leipsic, 1731.—Isenflamm has described and figured them in his *Praktische Anmerkungen uber die Muskeln*, Erlangen, 1778, p. 345.

We sometimes find before it a proper, but much smaller muscle, o dilate the nostril; it is called the *myrtiform muscle of Santorini*, nd sometimes surrounds the nose like a sphincter.

D. DEPRESSOR NARIUM.

§ 2033. The *depressor narium* muscle forms on each side a small asciculus situated along the median line: it arises from the inner pper part of the orbicularis oris muscle, and is attached backward nd inward to the inner branch of the cartilage of the ala of the ose. It draws the cartilaginous nose downward and backward, and lso contracts the nostrils.

III. MUCOUS MEMBRANE.

§ 2034. The *mucous, olfactory, pituitary,* or *Schneiderian memrane of the nose*, has not the same nature in all parts. The proper asal portion is more than a line thick in some places; it is thick, very ed, and intimately fitted to the bones which it covers in every part; contains numerous depressions and mucous follicles, and also at the ower and inner part of the nose, some small yellowish and distinct lands, which are imbedded in its peculiar tissue. At the anterior nd inferior part of the nose it is thinner, harder, drier, and also proded with mucous follicles. If we except this latter portion, the tuitary membrane is covered in every part with very short villosities. t the lower edge of the septum there is not unfrequently a narrow nal, the direction of which is from behind forward, terminating steriorly in a cul-de-sac, and which opens at some distance behind e anterior edge, evidently above the organ of Jacobson.*

The mucous membrane of the accessory cavities or of the sinuses, externally thin, smooth, and yellowish white. It adheres but ghtly to the surface of the bony cavities it covers, undoubtedly cause numerous vessels and nerves do not enter it, through the bstance of the bones.

IV. NERVES.

§ 2035. The nose receives its nerves from two sources, the olfactory d the second branch of the trifacial nerve.†

The olfactory nerve is undoubtedly the proper nerve of the organ smell,‡ since when absent or compressed, the sense of smell is lost.

* Ruysch, *Thesaur. anat. III.* tab. v., fig. 5.—Jacobson, *Ann. du mus.*, vol. ii. p. 412.

† J. Hunter, *A description of the nerves which supply the organ of smelling; Obs. on different parts of the animal economy*, p. 239, tab. ix-xviii.—A. Scarpa, *. cit.*, cap. iii-vi.

‡ Magendie has doubted the proposition generally admitted in a memoir, ened "*Le nerf olfactif est-il l'organe de l'odorat?* In the *Journ. de phys. expér.*, . iv. p. 169." Mery already doubted that the olfactory nerve was the organ of ell, and asserted that it was supplied by the fifth pair. (Brunet, *Progrès de la*

From the lower face of the prominence which terminates it, two series of filaments arise, an external and an internal, which correspond to the two series of foramina in the cribriform plate of the ethmoid bone, although two or three of them frequently emerge through the same foramen. They vary much in number and size. There are from four to twelve. The anterior go downward and forward, the middle directly downward, the posterior downward and backward. Shortly after leaving the olfactory nerve they enter the sheaths of the dura-mater, within which the posterior, particularly, pass a long distance before entering the foramina of the cribriform plate. They are covered first by the dura-mater, and flattened by the arachnoid membrane, which is less compact, and does not attend them as far. Entirely on the outside, each is surrounded by a tunnel-like prolongation of the dura-mater, which extends very far, and makes them apparently larger than they are on leaving the ganglion. They anastomose below the cribriform plate, descend between the bones and the pituitary membrane, soon ramify very much, and thus gradually approach the loose surface of the membrane.

Part of the internal series belongs to the septum, the component nerves of which pass entirely through it: the middle are the longest and the posterior the shortest.

They descend side by side, forming a single layer.

The external series is distributed in the sides of the nose, particularly in the two superior turbinated bones, forms considerable anastomoses, but the filaments formed by these nerves are much less compact than those of the external: they do not enter into the ethmoid cellules, and do not go to the mucous membrane of the inferior turbinated bones, or at least send forward but few and very minute ramuscules.

The olfactory nerve sends no filaments to the pituitary membrane of the sinuses.

médecine, 1697.) Having opened the skulls of three or four men, in whom the organ of smell during life was unaltered, he found the pair of nerves callous near the cerebrum. Loder, however, (*Observatio tumoris scirrhosi in basi cranii reperti*, Jena, 1779,) has seen the olfactory nerve destroyed in a man destitute of the power of perception, and Oppert also has observed the same thing in a female, in whom the sense of smelling was deficient (*Diss. de vitiis nervorum organicis*, Berlin, 1815, p. 16). Cerutti (*Beschreibung der pathologischen Präparate des anatomischen Theaters zu Leipzig*, 1819, p. 208) mentions the cerebrum of a man who never possessed the faculty of smelling, in whom the olfactory nerve and its groove on the lower face of the inferior lobe were deficient. Rosenmuller even has described this case (*De defectu nervi olfac.*, Leipsic, 1817). But Rudolphi regrets, and with justice, that the turbinated bones of the septum were not examined, since in many cases, when it has been said to be deficient, it has been found but very soft and diffluent. Farther, the facts related by Magendie, seem to give some weight to the old opinion of Mery; at least they should draw the attention of physiologists to the sinuses of the nasal fossæ, to which Malacarne, Weinhold, Blumenbach, and Treviranus, have attributed very different uses, which are sometimes very trivial as those mentioned by Weinhold. It would be important to prove, whether, as Deschamps and Richerand assert from experiments made on subjects affected with diseases of these cavities, they are unconnected with the olfactory function; but of this we may doubt until we have more information, especially since the fine researches of Treviranus on the fifth pair of nerves. F. T.

Among the nerves of the fifth pair or the accessory nerves of the ose, the superior nasal nerves go backward, the middle and the ıferior nasal nerves, and the nerve of the septum which arise from ıe pterygo-palatine nerve, and the ethmoid nerve which comes from ıe nasal branch, go farthest forward, for they extend even before ıe olfactory nerve, and are distributed in the mucous membrane of ıe nose. These nerves also surround the surface in which the olfactory erve is distributed, and anastomose with its posterior and external laments. Those from the second branch of the fifth pair communi-.te also with the ethmoid nerve. Hence, the accessory nerves form complete circle around the expansion of the olfactory nerve, like at formed by the ciliary nerves around the retina. Although they oceed much farther, they however occupy much less space than the vigs of the olfactory nerve.

§ 2036. The impressions of the odours are received by the olfactory erve, and directly by the pituitary membrane. The portion of this tter in which the olfactory nerve is distributed, seems to be the incipal seat of the faculty of perceiving them, although the mem-ane which lines the sinuses, partially contributes.

ARTICLE SECOND.

IFFERENCES IN THE NOSE DEPENDENT ON DEVELOPMENT.

§ 2037. We have already mentioned in osteology, the principal riodical differences in the bony nose.

The whole organ long continues very imperfect. There is no trace the external nose until the seventh or eighth week of pregnancy. this time the nostrils appear, separated by a proportionally very ɔad septum, as two very small openings; little later the nose begins project over the mouth; but during pregnancy it is blunt, and ɔportionally very small; a large nose in an infant is very un-asant, because it is a character foreign to the early periods of life. The cartilaginous structure of the external nose does not begin to ɔear till towards the end of the third month.

Until the end of the second, the nasal cavity communicates with t of the mouth. It is at first very narrow from above downward, l from right to left, on account of the greater breadth of the septum. The nasal canals are formed at the end of the second month, by still membranous prominences of the turbinated bones.

ARTICLE THIRD.

ORGAN OF SMELL IN THE ABNORMAL STATE.

A. NOSE.

§ 2038. The primitive deviations of formation in the nose* are:

1st. Its entire deficiency, which is very rare, is generally attended with the fusion of the two eyes in one.

2d. The union of the two halves of the nose in a tube situated below the single eye.

3d. Greater or less openings in the septum.

4th. Narrowness or closing of the nostrils.

5th. The abnormal communication of the cavity of the nose with that of the mouth, by the deficiency of a greater or less portion of the palate.†

6th. The more or less evident want of symmetry arising from an obliquity in the septum, which is sometimes so great that this latter even touches the wall towards which it inclines.

Most of these primitive deviations of formation are developed also consecutively during life, after the bony and musculo-membranous parts of the nose and palate are destroyed by syphilis.

The most frequent abnormal formations are the polypi of the pituitary membrane. Hydatids are infinitely more rare. They sometimes become so large that they considerably contract the nasal cavity.‡

B. SINUSES OF THE NASAL FOSSÆ.

§ 2039. The *accessory cavities* or the *sinuses of the nasal fossæ*, present numerous and frequent anomalies.§

Their deviations of formation consist in their absence and narrowness, which are usually congenital. Sometimes these sinuses do not communicate with the nasal fossæ: but this anomaly almost always occurs, consecutively, after inflammation.‖

Once, however, we found in the cadaver of an old woman the two maxillary sinuses completely closed, without any pathological change

* Deschamps, *Traité des maladies des fosses nasales et de leurs sinus*, Paris, 1804, p. 8.

† Portal, *Anat. méd.*, vol. iv. p. 499.

‡ Idem, *loc. cit.*

§ L. H. Runge, *De morbis præcipuis sinium ossis frontis et maxillæ superioris*, Rinteln, 1750.—Bordenave, *Sur les maladies du sinus maxillaire*; in the *Mem. de l'ac. de chir.*, vol. iv. 329.—C. A. Weinhold, *Ueber die krankhaften Metamorphosen der Highmorshöhle*, Leipsic, 1810.—F. D. Wagner, *Diss. de polypis narium et antri maxillaris*, Berlin, 1821.

‖ A.F. Rohowsky, *Diss. de choanarum obliteratione*, Berlin, 1815.—Otto, *Pathologische Anatomie*, p. 203, ann. 15.

the texture of the pituitary membrane, and their surface also was
ist as usual.

A greater or less quantity of liquid, however, oftens collects within
m, from the effect of certain causes; this more or less forcibly dis-
nds them, their parietes become thinner, and are finally destroyed
en the compression continues a long time, although this state does
t deserve the name of *dropsy of the maxillary sinus*, because the
sed liquid is not of the same nature as that exhaled by serous
mbranes.*

Entirely new formations, as fibro-cartilages and polypi, either alone
united, are not unfrequently developed in the accessory cavities of
nose. These formations are particularly common in the maxillary
us, which is the most subject to morbid alterations, doubtless on
ount of the nearness of the teeth, and because the situation of its
ning renders the escape of its secret fluids more difficult. We
y, however, blend them with the analogous tumors which are deve-
ed out of the antrum Highmorianum, in the zygomatic fossa.†

SECTION II.

OF THE VISCERA OR FORMATIVE ORGANS.

2010. The *viscera*, ‡ which may also be called the formative
ans, because their essential function is to form new substances,
sent several general characters, the principal of which are as
ow:—

st. They are situated principally in the trunk, and occupy only
nall part of the lower region of the face, and are generally placed
cavities formed by bones, muscles, and serous membranes, which
y much in capacity. An aqueous vapour is effused between them
l the parietes of these cavities.

2d. They are entirely, or at least in great part, and in their most
portant portions, enveloped by serous membranes. Each system
eparated in this manner from the others, and each occupies a dis-
ct section of the trunk.

3d. They receive most of their nerves from the ganglionnary sys-
, and their nerves are always proportionally larger than those that
to the organs of sense, excepting always certain parts, as the
gue and the external organs of generation, which being abun-
ntly supplied with nerves, possess a very acute and special sensi-

Runge, *loc. cit.*—Fauchard *Chir. dentiste*, vol. i.—Sauve, *Cas d'hydropisie inus maxillaire*; in the *Bull. de la fac. de méd.*, 1818 p. 9.

Lesage, *Sur une tumeur enkystée de la fosse zygomatique prise pour un polype inus maxillaire*; in the *Bull. de la fac. de méd*, 1816, vol. v. p. 268.

‡ C de Garengeot, *Splanchnologie, ou l'anatomie des viscères*, Paris, 1742.—ard, *Traité de splanchnologie*, Paris, 1809.—Boyer, *Traité de splanchnologie*, s, 1815.

bility, and are in fact real organs of sense. Most of the viscera receive their nerves from the ganglionnary system, and next from the pneumogastric nerve; but the hypoglossal, the glosso-pharyngeal, and the trifacial nerves, are also distributed in their upper portion, and the inferior spinal nerves in their lower portion.

The nerves usually pass some distance before arriving at the organs, and generally each of the latter receives nerves from one pair only. One pair of nerves is distributed in part to several organs.

4th. The course of the nerves in most of their extent is constant. As this condition does not exist in regard to those organs which receive their nerves from the ganglionnary system, we must conclude that it does not depend on the nature of this nerve. It is false that the spiritual principle is not connected with them, and the changes that take place in them are not perceived; this perception is very manifest in disease, and the sensations that result from them are not more vague or obscure than those ascribed to all the organs except that of sight.

5th. All the viscera are not united, at least in the perfect state, by mucous membranes. The respiratory and digestive systems communicate together in the neck, the urinary and genital systems in the lower part of the trunk; but the two latter are separated from the digestive system, or at least are connected with it only by the skin.

6th. These organs are much less symmetrical as to form and situation, than those of the senses.

7th. Their most important part is more or less evidently glandular. All are formed by several glands, the combined action of which is to correct the fluids secreted by them. The necessity of the combined action of several glands is very evident in the most complex system, that of digestion. Next come in this respect the genital organs, especially those of the male. The concurrence of several glands to form a new substance, seems least necessary in the urinary and respiratory systems.

A second part is composed of a canal formed of several different superimposed membranes, united by cellular tissue, and with which the gland or glands in general communicate, and which is sometimes open at its two extremities like the alimentary canal, or at one only, like all the others. The nature of the parietes of this canal varies extremely; they are, however, always formed of at least two superimposed layers, the external of which is condensed cellular tissue, and the internal a mucous membrane. The mucous membrane is covered sometimes in every part, as in the alimentary canal, sometimes here and there by a muscular tunic.

8th. These organs, if we except the genital organs, are, next to the centres of the nervous and circulatory systems, the most necessary for the support of life, although some of their parts may be primitively deficient, or be destroyed in some manner without occasioning severe accidents, and although very considerable alterations do not occasion immediate death.

CHAPTER I.

OF THE DIGESTIVE ORGANS.

§ 2041. The digestive organs comprise an uninterrupted canal pen at its two extremities, and several appendages, which commu-icate directly or indirectly with different parts of this canal, within hich they empty a fluid prepared by them.

This passage is termed the *alimentary canal* or *tube* (*canalis*, s. *ictus cibarius*). Its upper extremity is the mouth (*os*), and the lower e *anus*; both are situated opposite each other, and nearly on the me line. The canal is imperfectly divided by valvular prominences to several separate portions, which are named according to their rm or functions. It is very convenient to admit three parts, which ffer in functions, structure, and situation, but which are all repeti-ons of the same type; these are the *upper*, the *middle*, and the *lower* ortion. The first occupies the head, the neck, and the chest; the her two, which form most of the digestive system, fill almost en-ely the cavity of the abdomen. The upper portion is composed of e *oral cavity* (*cavum oris*), the *pharynx*, which is smaller than the outh, and the *esophagus* (*gula*, *œsophagus*), which is still narrower, d with which the pharynx is continuous. Directly after passing rough the diaphragm the alimentary canal enlarges to form a se-nd pouch, called the *stomach* (*ventriculus*, *stomachus*), which is the mmencement of the middle portion. Next comes a second nar-wer portion, the *small intestine* (*intestinum tenue*), which is divided, m slight and inessential differences, into the *duodenum*, the *jeju-m*, and the *ileon*. The latter is continuous with the terminating tion of the intestinal canal, the *large* intestine or the *colon* (*intes-um colon*, s. *crassum*), which is divided according to the situation d direction of its different parts into an *ascending*, a *tranverse*, and a *cending colon*. The latter is continuous also with the *rectum*, which ns at the *anus*. The small and the large intestines are termed the *estinal canal* (*ductus*, s. *canalis intestinalis*).

The appendages of the intestinal canal are glandular organs re-nbling conglomerate glands; they are, the *salivary* glands and the *er*.

The *salivary* glands (*G. salivares*) are situated round the cavity of mouth, into which their secretion goes, and in the abdominal ca-y near the upper extremity of the small intestine. They are con-uently divided into the *oral* and the *abdominal salivary* glands (*G. ivares orales et abdominales*).

The *liver* (*jecur*, *hepar*) also occupies the cavity of the abdomen. fluid it secretes is termed *bile*, and is poured into the duodenum r the last salivary gland.

We also find in the abdomen a glandular organ, which has no excretory canal, called the *spleen* (*splen, lien*).

All the portions of the digestive system in the abdomen, except the lower part of the rectum, are surrounded by a common serous membrane, the *peritoneum*.

§ 2042. The alimentary canal* presents several general characters which are simply modified in its component parts.

The tube it represents is formed of several layers which belong to different systems, so that each concurs specially to the general function.

The most internal and the most essential of these layers is the *mucous* or *villous* membrane (*tunica mucosa*, s. *intima*, s. *cribrosa*, s. *villosa*). It is soft and more or less vascular, incloses numerous small culs-de-sac or small muciparous glands, and its surface is moistened by the mucus which it constantly secretes, and a thinner fluid which is exhaled from it. It is in direct contact with the ingesta. The liquid which it secretes has a chemical and also a dynamical relation with the ingesta, since its action changes their composition, and they are divided into two parts, one of which, the *chyle* (*chylus*), serves for nutrition, while the other, the *fecal matter* (*fæces*), being useless, is expelled from the body. The chyle in its turn is so modified that it enters into the absorbing vessels which exist in this tissue.

The differences in this membrane relate principally:

1st. To its thickness.

2d. To its vascularity.

3d. To its colour, which depends on the number of its vessels.

4th. To its solidity.

5th. To its extent, compared with the other membranes.

6th. To the presence or absence of prolongations and folds which project within it and vary in size, the former of which are called *valves*, the others *villosities*.

7th. To the nature of its surface, which is smooth or corrugated, and which depends on the preceding circumstance.

8th. To the number of the muciparous glands.

9th. To their size.

10th. To their situation and arrangement.

We may mention as a general law that the development of the inequalities on the inner face is inversely as that of the muciparous follicles, or still more generally that the prominences are inversely as the depressions; that the first are more distinct, the more nutrition there is in the contents of the intestinal canal, and that the cavities are more marked, the greater the quantity of fecal matter in the canal.

Considered from the commencement of the stomach to the extremity of the intestinal canal, the general character of this membrane is that it is perforated by very numerous small openings, which are the ori-

* F. Glisson, *De ventriculo et intestinis*, London, 1676.

es of single minute glands, and which are arranged very compctly.*

On its surface is a second membrane termed the *nervous*, or rather e *cellular* coat (*tunica nervea, cellulosa*).

This membrane is only condensed cellular tissue, in which the gest trunks of the vessels and nerves are distributed before riving at the mucous membrane.

It contributes much to determine the form of the intestinal canal d of its folds.

The most external membrane is the *musculur* tunic (*tunica muscua*).

This membrane is composed in every part by several, at least two, perimposed layers, situated one above the other, and separated only a very thin layer of mucous tissue.

The external layer is generally composed of longitudinal fibres, ich are parallel to the axis of the intestinal canal and of the body. is thinner than the internal, and it is extended on the intestine less iformly.

The internal, on the contrary, is composed of circular fibres, is onger than the external, and completely surrounds the intestinal be.

The differences presented by this muscular tunic in the different gions of the alimentary canal relate:

1st. To the relation between it and the mind, according as its tions are voluntary or involuntary; in most of its extent these are oluntary; they, however, are voluntary at its upper and lower part.

2d. To its thickness and strength.

3d. To its more or less complex texture.

4th. To its colour.

5th. To its attachments, according as it is inserted in the bones connected with the adjacent parts by mucous tissue.

Besides the three layers there are also two others which are not generally distributed: one resembles the epidermis, and covers inner membrane; the other is given off by the peritoneum, and velops the external tunic.

The most general character of the glandular appendages of the mentary canal is, that these parts, except the spleen, are prolongans of the mucous membrane, and of the cellular tunic, each of ich ramifies like a tree. They differ then from the muciparous nds on the external face of the villous tunic, because they are her more distinct and are more concentrated in some parts of the nentary canal.

* Galeati, *De tunicâ intestinorum cribrosâ*; in the *Comm. Bonon.*, vol. i.—erney, *Œuvres anatomiques*, vol. i., p. 480.—A. Meckel, *Sur la structure de la mbrane muqueuse des intestins dans l'homme et dans quelques animaux*; in the *rn. compl. des. sc. méd.*, vol. vii., p. 209.

ARTICLE FIRST.

UPPER PORTION OF THE ALIMENTARY CANAL.

§ 2043. The upper portion of the alimentary canal may be subdivided into two regions, a *cephalic* and a *cervical* region.

I. CEPHALIC PORTION OF THE ALIMENTARY CANAL.

§ 2044. The cephalic portion of the alimentary canal comprehends the cavity of the mouth and the parts within it.

A. ORAL CAVITY GENERALLY.

PERFECT STATE.

§ 2045. The *oral* cavity (*cavum oris*) occupies the lower part of the face. It extends backward to the *fauces* and forward to the *lips*, by which it is continuous with the face. It is separated from the nasal fossæ above by the *bony* palate (*palatum osseum*, s. *durum*), and backward by the *soft* palate (*palatum molle*, s. *velum palati*). At its base is the tongue, and on its sides the lower jaw, the zygomatic arch and the muscles, some of which are attached to these bones, others to other pieces of bone, and several of which also go to the mouth.

As the oral cavity is circumscribed by muscles and by bones which are moveably articulated with each other, its form varies, although in general it is rounded and oblong. The alveolar portion of the upper and lower maxillary bones, together with the teeth which are inserted there, divide it into two halves, an anterior, which is smaller, and which may be called the *vestibule of the oral cavity*, and the posterior, which is larger. The first is included between the alveolar processes and the lips; the second is situated behind the alveolar arches. These two halves are perfectly separated from each other when the jaws are closed by the two rows of teeth which touch and fit each other from before backward. When perfectly at rest the posterior half contains the tongue and receives the excretory ducts of the inferior salivary glands, while those of the superior open into the anterior half. The oral cavity is covered on the outside by the common integuments, below which are the bones and muscles, then the *buccal* membrane (*membrana oris*), which envelops every part of it.

The buccal membrane in fact begins at the upper part of the external faces of the lips, where the skin suddenly becomes softer, thinner, and redder.

It lines all the parts which circumscribe the cavity of the mouth, › that it perfectly closes the openings in the bony portion of the alate, the anterior and posterior palatine foramina. Around the lveoli it is uninterruptedly continuous with the membrane which overs them.

It forms folds in several places. Four of these folds are situated on e median line. The two most anterior exist between the centre of ie anterior faces of the two maxillary bones and the upper and wer lips. They are both termed the *frena* of the lips (*frenum labii superioris et inferioris*). The upper is much more distinct an the lower, which generally is hardly visible. The third is uated between the posterior face of the lower jaw and the anterior .rt of the inferior face of the tongue; it is called the *frenum of the ngue* (*frenulum linguæ.*)

When too long or too short it is equally unfavourable to deglutition d speaking.

The fourth extends from the posterior extremity of the upper face the tongue to the middle of the anterior face of the epiglottis.

The buccal membrane also forms:

1st. Two lateral folds, which extend from the upper face of the ngue to the edges of the epiglottis, where they terminate.

2d. Two lateral folds, situated on the anterior part, which extend m the alveolar edge of the two jaws to the inner face of the ramus the lower jaw.

3d. Two other lateral folds, which cover the two arches of the soft ate.

Of these folds the most remarkable are those on the median line, they make a part of the septum which extends all along the body. The texture of the buccal membrane is not the same in every part. however always presents two general characters:

1st. It is covered in every part by a soft, thick, and moist epi-mis.

2d. It presents almost in every part single and large muciparous nds.

II. DIFFERENCES DEPENDENT ON DEVELOPMENT.

2016. The form of the oral cavity changes remarkably. In the ly periods of life it is proportionally shorter from before backward, ecially at its lower part than when the subject is fully grown. At time the lips do not exist, so that the oral cavity is uninterruptedly tinuous with the face, and its roof, the palate, not being closed, it ended with the nasal fossæ, toward the upper part of which is the gue, then proportionally very large. This horizontal septum is lually developed from before backward by the union on the median of the palatine portions of the superior maxillary and the palatine es, and also the soft palate on each side. This union is rarely

perfect before the third month of fœtal existence. The soft palate is perfect on the median line even before its two lateral parts are thoroughly united posteriorly, and the uvula descends from their centre between them as an entirely distinct and separate appendage. This soft palate is at first very broad, presents no appearance of an appendage, and is divided in its whole extent into two lateral halves. This division soon disappears, and at the same time the two lateral halves of the soft palate approach each other still nearer, and thus push the uvula a little forward, so that it covers the small fissure still existing in the anterior region of the palate. At this time its upper part is united to the two lateral halves, and the inferior passes downward a little below it. Finally the two halves of the soft palate completely unite with each other and with the uvula, and the formation is completed by the gradual prolongation of the latter. The perfect union of the uvula with the soft palate occurs at the middle or the end of the fourth month of pregnancy. The uvula, however, until the end of the fifth month continues to be bifurcated, compared with its state in the adult, although it is united on each side with the soft palate, so that perhaps this period of its development is frequently extended beyond the usual time, although terminated before the end of gestation.

III. ABNORMAL STATE.

§ 2047. The most remarkable abnormal state of the cavity of the mouth is when its primitive formation continues, that is, when it communicates with the face and nasal-fossæ, and the primitive fissures are not obliterated. This state of the upper lip is termed *hare-lip*, and that of the arch of the palate is termed *fissure of the palate*.* Generally then the solution of continuity in the lip or palate, excepting in the uvula, does not correspond to the median line, but occurs on one of the two sides, since it is situated also like the fissures by which the lips communicated primitively with the face. Farther, in the simple fissure of the palate we generally remark that the anterior and intermaxillary portion of the upper maxillary bone on one side is separated from the posterior; at least the solution of continuity is rarely situated on the median line, and the intermaxillary bones are seldom attached each to the corresponding maxillary bone, and the two maxillary bones with the palatine bones are not often separated symmetrically from each other and from the septum of the nasal fossæ.† The mode in which the uvula is developed explains why fissures in it are situated on the median line.

* Sandifort, *De labio leporino congenito, duplici et complicato*; in the *Obs. anat. pathol.*, book iv., ch. iii.—Tenon, *Sur quelques vices de la voute palatale*; in his *Mém. et obs. sur l'anatomie*, Paris, 1816, p. 25.

† Tenon, *loc. cit.*, obs. i.

It is curious that however great this deviation of formation, it somemes disappears at a more advanced period, and assumes the normal onditions of the regular type; the bony palate increases either alone r after the hair-lip is united, and the space between the oral and asal cavities gradually fills up. This fact supports our previous conecture that the two halves of the uvula sometimes unite in the fœtus fter the usual period of union.

The oral cavity presents those alterations of texture observed in all e mucous membranes. One of the rarest anomalies of this class is e development of hairs, which have been observed once on the surce of an encysted tumour in the fauces of a newly born infant.* has been asserted that they have been seen also on the tongue †

B. PARTS WHICH COMPOSE THE ORAL CAVITY.

§ 2048. The different regions of the oral cavity are:
1st. The *lips.*
2d. The *cheeks.*
3d. The *palate.*
e proceed to describe also:
4th. The *tongue.*
5th. The *teeth.*
6th. The *oral salivary glands.*

I. LIPS AND CHEEKS.

A. FORM.

2049. The *lips* (*labia*) are prolongations which cover the anterior e of the alveolar edge of the jaws, being parallel with it. Their se edges which look towards each other are more or less enlarged l turned over, that of the lower always more than the upper. The ning between them is termed the *mouth* (*os*).

The upper lip is longer and more prominent than the lower. We ark in it on the median line a longitudinal depression called the *ltrum*, which extends from the septum of the nose to the place re the skin becomes much thinner. This depression is remarke on account of the space which primitively existed at the same ce between its two lateral halves.

n the lower lip there is nothing similar, a difference which should considered:

st. Because we know of no instance of a fissure of the lower lip.

* Ford, in the *Méd. communic.*, vol. I., no. 51.
† Amatus Lusitanus, *Cæs. med. cent.*, ch. vi., p. 63.

2d. Because the depression of the upper lip seems to depend on the greater extent of the superior frenum, and on the separation of the superior maxillary bones, which always continues during life.

The places where the two lips unite are termed the *angles of the mouth* (*anguli oris*).

The lips are insensibly continuous on each side with the *cheeks*. Both regions are formed by a cutaneous, a muscular, and a mucous layer.

B. MUSCLES OF THE LIPS.

§ 2050. The different changes in the form of the cavity of the mouth, are produced by the action of the following muscles which occupy the regions of the lips, the cheeks, and the chin.

a. Orbicularis oris.

§ 2051. The *orbicularis oris* muscle, *buccal*, Ch. (*M. annularis, obicularis oris, sphincter oris*), principally forms the fleshy layer of the lips, surrounds the mouth, and is situated between the skin and the mucous membrane. It is oval, thin, flat and broad, and is formed of concentric fibres. The external blend insensibly with those of its antagonists, or are prolongations of fibres of these different muscles which interlace together. These external fibres, however, are distinct, and are not blended. The internal form a separate order. They are found near the loose inner edge of the muscle and of the lips; but they insensibly disappear in the external fibres.

This muscle is united more intimately with the skin than with the mucous membrane. It contracts and closes the mouth, and draws up its angles.

b. Buccinator.

§ 2852. The *buccinator* muscle, *bucco-labial*, Ch., is situated between the upper and lower maxillary bones and the orbicularis oris muscle. It is square, broad, thin, and flat. Its fibres have generally a transverse direction ; the upper, however, go obliquely from above downward and from behind forward, the inferior proceed in the opposite direction, and the central alone are straight. Its fixed points are the superior and the inferior maxillary bones. It arises from the external face of the alveolar edge of these two bones; its attachments commence behind the last molar tooth, and extend to about the second anterior. It also arises at its posterior part from the summit of the internal wing of the pterygoid process, and from a ligament which extends from that point to the alveolar edge of the lower maxillary bone. It is blended forward with the orbicularis oris muscle. The canal of Steno passes through it, near its anterior extremity.

It draws the lips and the whole mouth directly backward, contracts the cavity of the mouth, and consequently expels the substances in this cavity, so that it acts in blowing, whistling, expelling liquids from the mouth, sucking, forming the mass of food on the tongue, and in swallowing.

§ 2053. We may distinguish into *upper* and *lower* the following muscles which contribute to open the mouth.

The *upper* are, considering them from without inward:

c. d. Zygomatici.

§ 2054. The *zygomatici* muscles, *zygomato-labiaux*, Ch., are two in number, a *large* and a *small* (*M. zygomaticus major et minor*). Both are elongated and thin. The large is more round than the small, and is also situated further outward and backward. Both arise from the external face of the molar bone; sometimes, however, the small comes only from the external and inferior part of the orbicularis palpebrarum muscle, which generally sends some fibres to them. Both go obliquely from above downward, from without inward, and from behind forward. They blend with the orbicularis oris muscle; the small with that portion of this muscle which makes part of the upper lip; the large with that which extends to the angle of the mouth and to the lower lip.

Sometimes the zygomaticus minor muscle is deficient; in other cases its lower extremity is bifurcated; in some subjects it does not descend to the orbicularis oris muscle, but terminates in the outer face of the levator labii superioris and the levator anguli oris muscles.

These muscles draw the skin of the cheeks, the commissure of the lips, and the whole mouth, downward and outward. They consequently contribute to enlarge the mouth, particularly when they act on both sides at once.

e. Levator anguli oris.

§ 2055. The *levator anguli oris* muscle, *petit sus-maxillo-labial*, Ch. (*M. levator anguli oris*, s. *caninus*), is broader than the preceding, and is flat and elongated. It arises in the canine fossa below the infraorbitar foramen, descends almost perpendicularly, becoming thicker and narrower, and blends in the angle of the mouth behind the zygomaticus major muscle with the orbicularis oris, and still more with the depressor labii inferioris muscle.

It raises the angle of the mouth and the upper lip.

f. Levator labii superioris.

§ 2056. The *levator labii superioris* muscle, *moyen sus-maxillo-labial*, Ch., is much larger than the preceding, and partly conceals its upper extremity, being covered in this place by the orbicularis palpebrarum;

it has nearly the same form but a different direction, for it descends obliquely from without inward. It arises from the upper maxillary bone above the infra-orbitar foramen and is attached to about the middle of the upper lip, so that its fibres blend with those of the orbicularis oris, before which it descends.

It draws the upper lip obliquely upward.

g. Anomalus faciei.

§ 2057. Below the preceding and the levator alæ nasi labiique superioris muscle we not unfrequently find a long muscle which arises near the canine fossa of the upper maxillary bone, and is attached directly above the origin of the preceding; it is termed the *anomalus faciei* by Albinus :* the *rhomboideus* by Santorini.†

It assists to raise the upper lip, and wrinkles the skin which covers it.

h. Levator alæ nasi labiique superioris,

This muscle has already been described.

§ 2058. The lower muscles of the mouth, considered in the same order as the preceding, are, the *depressor anguli oris,* the *depressor labii inferioris,* and the *levator menti* muscles.

i. Depressor anguli oris.

§ 2059. The *depressor anguli oris* muscle, *maxillo-labial,* Ch., called from its form the *triangular muscle of the lips,* arises from the anterior part of the lower edge and the anterior face of the lower maxillary bone. It ascends, contracting and becoming thicker towards the angle of the mouth, where it blends with the orbicularis oris, the zygomaticus major, and particularly the levator labii superioris muscle, so as to form with this latter a single muscle very much contracted in its centre, the fibres of which, however, are not interrupted by a median tendon.

When the lower part of the muscle formed by the union of the levator labii superioris and the depressor anguli oris acts alone, it draws the angle of the mouth and the lower lip downward, as in weeping. This muscle also enlarges the mouth tranversely by its external fibres. When acting alone it contributes to raise the lower jaw.

* *Hist. musc.,* p. 167.
† *Obs. anat.,* ch. i, § 25.

j. Depressor labii inferioris.

§ 2060. The *depressor labii inferioris* muscle, *mento-labial*, Ch. *quadratus menti*), is thin and square. It is covered at its lower part y the preceding, and slightly above by the base of the zygomaticus najor muscle; it arises farther forward and lower than the depressor nguli oris muscle, ascends obliquely from without inward towards ie lower lip, interlaces and intercrosses with that of the opposite side y its upper and inner part, and terminates in the orbicularis oris uscle.

It draws the lower lip obliquely downward and turns it over.

This muscle and the preceding generally blend with the upper part f the platysma myoides muscle.

k. Levator menti.

§ 2061. The *levator menti* muscle is small, thick, semicircular, nd unmated. It is attached on each side to the anterior face of the wer jaw, below the alveolar process of the canine tooth, occupies ie triangular space between the two depressor muscles, and terminates in the skin of the chin.

It raises the lower lip and skin of the chin.

II. PALATE.

A. FORM.

§ 2062. The *palate* (*palatum*) forms the arch of the mouth, which separates from the nasal fossæ. We distinguish in it two portions, a *anterior* or *osseous* portion, and a *posterior* or *soft* portion.

The *osseous* palate is composed of the horizontal or palatine portion f the superior maxillary and palatine bones, and also of the mucous iembrane extended on their surface. This membrane incloses a ayer of muciparous glands which is much thicker and more complex han that of the two preceding regions.

§ 2063. The *soft palate*, called also the *veil of the palate* (*palatum olle, s. velum palatinum*), forms a fold which extends obliquely from bove downward and from before backward from the posterior edge f the horizontal portion of the palatine bones toward the base of the ongue. Its lower edge is loose, and presents in the centre a rounded rolongation, termed the *uvula*,* on each side of which is a fissure. hese two fissured halves of the lower edge form the *inferior arches of ie palate* (*A. palatini inferiores*). The *superior arches* (*A. palatini*

* Lisfranc, *Considérations anatomiques, physiologiques et pathologiques sur la luette*; in the *Revue médicale*, vol. xi., p. 233.

superiores) are situated a little above. Both are continuous on the median line in the uvula.

The soft palate is formed of two layers of mucous membrane which cover its anterior and posterior faces, and are continuous with the pituitary membrane, of a very dense layer of muciparous glands situated between the two membranes, and of several muscles which contract and vary the form of the isthmus of the fauces (*isthmus faucium*).

A prominence resembling a cicatrix exists along the anterior face of the soft palate and the greater upper part of the uvula; this marks the primitive division of this part into two halves.

B. MUSCLES OF THE SOFT PALATE.

§ 2064. The muscles of the soft palate are distinguished into those which depress it and those which raise it. The first contract the isthmus of the fauces, the latter dilate it.

The muscles which contract the isthmus of the fauces are situated in the two arches; those which dilate it descend from the base of the skull and are directed from without inward.

a. Constrictors of the isthmus of the fauces.

§ 2065. The constrictor muscles of the isthmus of the fauces are two, the *palato-pharyngeus* and the *glosso-pharyngeus* muscles.

a. Palato-pharyngeus.

§ 2066. The *palato-pharyngeus* muscle or the *superior constrictor* of the isthmus of the fauces (*M. palato-pharyngœus*, s. *constrictor isthmi faucium superior*) arises from the upper part of the lateral wall of the pharynx, where its fibres blend with those of the superior and middle constrictors. Thence it enlarges, goes upward and inward, enters the soft palate, divides into an anterior and a posterior layer, which receive between them the levator palati mollis muscle, extends to the posterior extremity of the bony palate, and unites on the median line with that of the opposite side.

It depresses the soft palate.

b. Glosso-pharyngeus muscle.

2067. The *glosso-pharyngeus* muscle, or the *inferior constrictor* of the isthmus of the fauces (*M. glosso-pharyngœus*, s. *constrictor isthmi faucium minor*, s. *inferior*, s. *proprius*), a similar but much smaller muscle, ascends from the root of the tongue in the soft palate before the palato-pharyngeus muscle, with which it unites and arrives

at the lower arch, where it joins with that of the opposite side at the base of the uvula.

It depresses the soft palate, and particularly the uvula.

b. Muscles which dilate the isthmus of the fauces.

2068. There are two muscles also which dilate the isthmus of the fauces, the *levator* and the *tensor palati mollis* muscles.

a. Levator palati mollis.

§ 2069. The *levator palati mollis* muscle (*M. levator palati mollis, petro-salpingo-staphylinus*)), *pétro-staphylin*, Ch., is oblong and almost rounded; it arises from the centre of the anterior edge of the petrous process, and from the osseous portion of the Eustachian tube, and also from the posterior part of the commencement of its cartilaginous portion, by a short and strong tendon, goes inward and downward, enlarges but becomes thinner, and blends with that of the opposite side; it forms in the soft palate between the two layers of the palato-pharyngeus muscle an arch, the convexity of which looks upward, and the concavity downward.

It raises the soft palate, and extends it transversely.

b. Tensor palati mollis.

§ 2070. The *tensor palati mollis* muscle, *ptérygo-staphylin*, Ch. (*M. tensor palati mollis, circumflexus palati, pterygo-salpingo-staphylinus*), is broad, thin, and quadrilateral. It arises a little inward and outward from the upper extremity of the pterygoid process behind the pterygoid fossa on the inside of the oval foramen of the sphenoid bone; it frequently comes also from a greater or less extent of the posterior edge of the internal layer of the pterygoid process, and from the outside of the cartilaginous portion of the Eustachian tube. It goes downward and downward and becomes a flat tendon, which turns on the hook of the pterygoid process, a mucous bursæ existing between them; it is attached by its anterior edge to the posterior edge of the palatine arch, and always blends with the tendon of that of the opposite side to form the upper part of the soft palate.

This muscle extends the soft palate and draws it outward, and contributes, like the preceding, to dilate the isthmus of the fauces.

c. Palato-staphylinus.

§ 2071. The uvula or the central portion of the palate, the base of which is pointed, is composed of numerous muciparous glands, which are every where surrounded, sometimes by one sometimes by two

muscles, termed the *palato-staphylinus*, (*M. uvulæ*, s. *azygos uvulæ*). This muscle is always very long, and descends from the palatine spine and the anterior face of the tendon of the tensor palati mollis muscle. By contracting it shortens the uvula.

III. TONGUE.

A. NORMAL STATE.

§ 2072. The *tongue* (*lingua*)* is the principal organ of taste, and also of speech and deglutition.

We may consider it as the lower part of the cavity of the mouth, and consequently of the alimentary canal, which is considerably enlarged, and which from this fact projects within the cavity.

Its form is oblong, its edges are rounded, and it gradually becomes thin from behind forward.

Its posterior part is termed the *root*, and the anterior part the *point* or *apex*. It extends forward and on the sides much beyond its base of support, so that it is loose in these two regions, which form most of it. Its integuments are uninterruptedly continuous with the buccal membrane, which forms below its point a longitudinal fold of a very firm tissue, which is attached to the centre of the inner face of the lower maxillary bone, fixes the organ more firmly to the part it occupies, and is termed the *frænum linguæ*.

As the tongue is formed chiefly by muscles, it assists in articulation and deglutition, while on account of its membranes it is the organ of taste.

Its base is formed posteriorly by the hyoid bone.

a. Muscles of the tongue.

§ 2073. The muscles of the tongue† may be distinguished into the muscles of the hyoid bone and the proper muscles of the tongue.

* M. Malpighi, *De lingua*, Bologna, 1665.—G. Fracassati, *De lingua*.—L. Bellini, *Gustus organon novissime detectum*, Bologna, 1665.—L. Heister, *De lingua sana et ægrota*, Altdorf, 1716.—A. F. Walter, *De lingua humana*, Leipsic, 1724.—J. Reverhorst, *De fabrica et usu linguæ*, Leyden, 1739.—Royen, *De fabrica et usu linguæ*, Leyden, 1742.—J. A. Rinder, *De linguæ involucris*, Strasburg, 1778.—Bauer, *Sur la structure de la langue*; in the *Journal compl. des sc. méd.*, vol. xiv., p. 181.—Gerdy, *Discussions et propositions d'anatomie, de physiologie et de pathologie*, Paris, 1823, p. 19, pl. i. and ii.—Blandin, *Sur la structure et les mouvemens de la langue*; in the *Archiv. gen. de méd.*, vol. i., p. 437.

† Isenflamm, *De motu linguæ*, Erlangen, 1793.

a. Muscles of the hyoid bone.

1. Mylo-hyoideus.

§ 2074. The *mylo-hyoideus* muscle (*M. transversus mandibulæ*, s. *ylo-hyoideus*) fills the larger anterior part of the space between the vo halves of the lower jaw, viz., the two halves of the horizontal ortion and the body of the hyoid bone. It is loose outward in nearly s whole extent, and is covered in its centre by the anterior belly of e digastricus muscle of the lower jaw.

It is a triangular and thin muscle, the external convex edge of hich arises from a corrugated line on the inner face of the horizontal rtion of the lower jaw, and proceeds from before backward and om within outward. It enlarges considerably from before backward. s anterior fibres are transverse. The posterior are directed from fore backward and from without inward, and proceed toward those the opposite side. It descends from without inward, and unites th the latter on the median line, being separated from it only by narrow tendinous band which extends from before backward to the gle muscle formed by this union. It is attached by the inner rtion of its posterior edge to the centre of the anterior face of the ddle piece of the hyoid bone.

This muscle supports those of the tongue, which rest on it, and o the sublingual gland, compresses the canal of Wharton, and the cretory ducts of the sublingual gland, sustains these parts, and ses the hyoid bone.

2. Genio-hyoideus.

§ 2075. The *genio-hyoideus* muscle is situated directly above the tre of the preceding, next to the synonymous muscle of the opposite e. It has the form of a very elongated triangle, and arises from the per part of the anterior face of the body of the hyoid bone, goes from ind forward, and from below upward, gradually becomes thinner l rounder as it ascends, and is attached to the lower part of the ernal mental process directly above the mylo-hyoideus muscle. Its erior and posterior attachments are by very short, tendinous fibres. t draws the hyoid bone upward and forward. When this bone is d by its depressor muscles it brings the lower jaw downward backward, so that it acts like the digastricus muscle of the lower .

ometimes it is deficient, or rather it is imperfectly developed, and eplaced by a smaller muscle, which arises from the median tendon he preceding, and is attached to the digastricus muscle.*

* Duille, *Var. musc.*, Landshut, 1815, p. 5.

3. Stylo hyoideus.

§ 2076. The *stylo-hyoideus* muscle (*M. stylo-hyoideus*, s. *levator ossis hyoidei*) is thin, elongated, and rounded. It arises by a short tendon at about the centre of the external face of the styloid process, goes forward, downward, and inward, presents near its lower extremity a fissure for the tendon of the digastricus muscle, and is attached to the anterior half of the external edge of the large horn of the hyoid bone opposite the thyro-hyoideus muscle.

It draws the hyoid bone upward and backward.

It is frequently doubled, which anomaly depends on the presence of a small accessory muscle.

4. Sterno-hyoideus.

§ 2077. The *sterno-hyoideus* muscle (*M. depressor ossis hyoidei*, s. *sterno-hyoideus*) is thin and elongated. It comes from the inner face of the first piece of the sternum and of that of the cartilage of the first rib, and sometimes also from the inner extremity of the clavicle; thence it goes directly upward, in its course approaching that of the opposite side, and becomes thicker and narrower. It is finally attached to the lower edge of the middle piece of the hyoid bone, directly at the side of the median line.

It draws the hyoid bone downward, and as this bone is attached to the lower jaw, when the other is not fixed by its levator muscles, it is also depressed so that it acts on opening the mouth.

Sometimes it blends below with the sterno-thyroideus muscle,* or arises from the centre of the clavicle.†

5. Omo-hyoideus.

§ 2078. The *omo-hyoideus* muscle, *scapulo-hyoidien*, Ch. (*M. retractor ossis hyoidei*, *omo-hyoideus*, *coraco-hyoideus*), is a very long, thin, and digastric muscle. Its inferior belly arises from the upper edge of the scapula, sometimes also from the small ligament extended over the coracoid fissure; goes upward and forward; between the sterno-cleido-mastoideus and the scalenus anticus muscles it becomes a tendon whence the superior belly arises, which is attached to the middle piece of the hyoid bone on the outside of the preceding, and blends more or less with the stylo-hyoideus muscle.

It draws the hyoid bone downward, backward, and a little to the side. This muscle frequently presents anomalies. It is rarely entirely

* Albinus, *Hist. musc.*, p. 202.
† Kelch, *Beytrage zur pathol. Anat.*, Berlin, 1714, p. 32.

icient: we have observed it once, on the left side, without a sub-ute. Its origin frequently varies. Sometimes the inferior belly broader, so that it extends to the upper angle of the scapula.* metimes it arises from the clavicle,† and it is then unusually rt. In some subjects the lower belly is divided into two heads, to ich its simple enlargement is an approximation.‡ One of these ıds is sometimes attached to the clavicle.§ In some cases it tes with the sterno-thyroideus muscle by its superior belly or by pecial head.|| More rarely it is not inserted in the hyoid bone in the transverse process of the sixth¶ or second? cervical** tebra.

b. Proper muscles of the tongue.

1. Genio-glossus muscle.

2079. The *genio-glossus* muscle (*M. expulsor, attrahens linguæ, enio-glossus*), the largest of all the muscles of the tongue, arises n the lower jaw by tendinous fibres which are inserted directly ve the genio-hyoideus muscle. It is situated against that of the osite side, which it does not leave because its direction is that of median line; it goes backward, enlarges much like a fan, and as the greater inner part of the tongue the whole length of this ın. It also gives off some fibres which go outward, pass on the owing muscle, sends several to the upper part of the pharynx, furnishes a few to the upper horn of the hyoid bone and the lottis.

t brings the tongue, the hyoid bone and the pharynx forward.

2. Hyo-glossus.

2080. The *hyo-glossus* muscle (*M. depressor linguæ*, s. *hyo-sus*, s. *basio-cerato-chondro-glossus*) is thin, and has a long square n. It arises from the outer part of the body of the bone, from external edge of its great horn, and from the summit of the small n, ascends toward the lateral part of the tongue, and contributes orm it.

draws the tongue downward.

* Albinus, *Hist. musc.*, p. 200.
† Albinus, *loc. cit.*, p. 201.
‡ Duille, *loc. cit.*, p. 11.
§ Kelch, *loc. cit.*, p. 31.—Sels, *De musc. variet.*, Berlin, p. 6.
|| Sels, *loc. cit.*, p. 5.
¶ Kelch, *loc. cit.* p. 32.
** Sels, *loc. cit.*, p. 4, 5.

3. Stylo-glossus.

§ 2081. The *stylo-glossus* muscle (*M. retractor linguæ, s. stylo-glossus*), the shortest of the small muscles which come from the hyoid bone, arises directly from its summit and also from the upper part of its circumference, and arrives at the root of the tongue, in which it expands like a fan to its point, interlacing more or less with the hyo-glossus and the genio-glossus muscles.

It draws the tongue obliquely backward to its side, and enlarges it when it acts with its synonymous muscle.

We have once found it double on both sides.

4. Lingualis.

§ 2082. The *lingualis* muscle is thin and narrow. It extends from before backward the whole length of the tongue, and interlaces principally with the hyo-glossus and the genio-glossus muscles.

It shortens the tongue, and carries its point backward.*

* Gerdy has described better than any one before him the lingual portion of the special muscles of the tongue, and has followed them through its whole extent. His conclusions are as follow:—

The tongue is composed of a membrane, a peculiar yellow tissue, a superficial lingual, two deep lingual, the transverse lingual, and the vertical lingual muscles, all of which are distinct, of the two stylo-glossi, the two hyo-glossi, the two genio-glossi, the two glosso-staphylini muscles, and the fasciculi of the hyo-glosso-epiglossus.

The lingual membrane is thick and cartilaginous on its lower surface, in which the subjacent muscular fibres are inserted.

The yellow tissue covers at the base of the tongue the enveloping membrane, which has no cartilaginous texture in this place. It adheres to the hyoid bone, to the epiglottis, and to many muscular fibres. Follicles exist within it.

The superficial lingual muscle covers the upper face and the edges of the tongue, adheres closely to its membrane, and is attached posteriorly to the yellow tissue. Its fibres go forward, some on the upper face of the tongue, converging toward the median line, others above and below its edges to its apex.

The deep lingual muscles are two small fasciculi situated on each side under the posterior two-thirds of the tongue. between the hyo-glossi and the genio-glossi muscles. Their fibres are attached posteriorly to the yellow tissue.

The transverse lingual muscles are situated under the superficial lingual, pass through the whole breadth of the tongue and between the lateral fibres of the superficial lingual muscle, which they cross at a right angle, and are attached to the membrane of the tongue under the edge of this organ. They are divided on the median line by a fibro-cellular raphe. They gradually curve more and more towards the base of the tongue.

The vertical lingual muscles extend from the upper to the lower lingual membrane, passing through the whole thickness of the tongue and the transverse lingual muscles, with which they intercross. They curve and become more and more oblique towards the base of the organ.

The fibres of the stylo-glossi muscles blend with those of the superficial lingual muscle above and below the edges of the tongue, and send a transverse fasciculus under the yellow tissue, which unites to that of the opposite side.

The hyo-glossi muscles are situated between the stylo- and the genio-glossi. Their anterior fibres are directed from the hyoid bone very obliquely upward and

b. Envelops of the tongue.*

2083. The mucous membrane which covers the tongue is charac-
zed principally by the great development of its papillary tissue,
by the facility with which the epidermis is detached from it.
he dermis is united to the muscular membrane more intimately
n with the subjacent parts in any other region of the body.
s upper face is extremely corrugated. The inequalities there
erved are:

st. *Folds.* These folds are seen principally on the posterior part
on the edges of the tongue. They are generally arranged regu-
, converge from without inward and from before backward, and
very compact. They are about half a line high and broad. The
rior present numerous transverse grooves. The posterior are
oth, and consequently their surface is less extensive than that of
preceding. Those at the most anterior part of the tongue are
regular and constant. In the middle of the back of the tongue
e is frequently a more or less evident longitudinal depression.

l. *Papillæ.*† The papillæ of the tongue are arranged very com-
ly, and cover also all its dorsal face. They are insulated only
e root of the organ, where also they enlarge very much.

hey vary much in form, and hence have been reduced into several
es.

hey are generally small, thin, triangular, and terminated by a
t or pointed summit.

ne latter are very much developed on the centre of the tongue
ard and on the edges. They are termed the *filiform papillæ*
illæ filiformes).

thers which are much larger, more distinct but fewer, do not exist
ery part, and are enlarged at their loose extremity into a rounded

rd to about the centre of the tongue. Some of the posterior rise perpendi-
ly to the base of the tongue; others blend with those of the superficial lin-
nuscle on the edges of the organ.

genio-glossi muscles are situated side by side on the inside of the hyo-glossi
he deep lingual muscles: their fibres radiate from the malar process to the
posterior fourths of the tongue, on the median line, to the hyoid bone, the
v tissue, and the lingual membrane. They pass from below upward through
ansverse and the superficial lingual muscle, and curve slightly upward and
rd in the thickness of the tongue.

glosso-staphylini muscles go from the sides of the soft palate on the edges
tongue, where they blend with the superficial lingual and the stylo-glossus
e.

hyo-glosso epiglossus is formed of small fasciculi, generally deficient in
which go from the hyoid bone to the yellow tissue, others from this tissue to
iglottis, others also from the epiglottis to the hyoid bone. F. T.

. A. Rinder, *De linguæ involucris*, Strasburg, 1778.

lbinus, *De diversitate papillarum linguæ humanæ*; in the *Annotat. acad.*,
i., ch. xiv.—Sœmmerring, *loc. cit.*, tab. i., fig. 1-3.

head, whence they are termed the *conical* or *fungiform* papillæ (*papillæ fungiformes*, s. *clavatæ*).

We must however remark, that in this respect they are frequently replaced by single filiform papillæ, which are longer and larger than the others. The fungiform papillæ lead to the largest of the papillæ of the tongue, which are situated at the base of the organ, vary much in number and size, and are arranged in two oblique series, which touch at one of their extremities, and thus form a V, the point of which looks backward. Their form is generally but not always conical, so that they enlarge considerably from their base to their extremity. They are situated in a depression which is continuous with the surface of the tongue by a sack with reversed edges. They are termed the *lenticular papillæ* (*papillæ truncatæ*, *capitatæ*, *circumvallatæ*): they are from three to twenty in number. Each depression commonly contains only one, but sometimes three or four, although this circumstance has no effect on their whole number, or on their size. They are not arranged symmetrically, although generally there is one which corresponds very nearly to the median line, and forms the point of the V.

This latter occupies the deepest of all the cavities, that which is termed the *lacuna*, the *foramen cœcum* of the tongue; beside which there is another situated behind it, and which incloses no papillæ.

We have several times thought, but wrongly, that we have discovered in this foramen cœcum the excretory ducts either of the salivary glands or of the thyroid gland.*

§ 2084. The papillæ of the tongue appear to the naked eye, and frequently when viewed by the miscroscope before they are injected, smooth in their whole extent and single; but when their vessels are injected, their surface presents several small asperities, which seem formed by collections of several fasciculi or filaments, placed one against another. This texture is more apparent in the larger and anterior, than in the smaller and posterior part.

Each filament contains at least one vessel; and when well injected, the whole surface of the tongue becomes red. These vessels form very complex arches and plexuses on the surface of the papillæ, since they frequently anastomose, and their loose extremities incline toward each other.

Each filament is also composed of a soft and whitish mass, which probably contains nervous substance. At least some filaments of the glosso-pharyngeal nerve have been traced into the posterior papillæ of the tongue, and some filaments of the lingual branch of the fifth pair into the others.

* Coschwitz, *De ductu salivali novo*, Halle, 1724.—Refuted by Duvernoy (*De ductu salivali Coschw.*, Tubingen, 1725), and by Haller (*Exp. et dub. circa ductum Coschw.*, Leyden, 1727).

.The arrangement of the vessels is more apparent in the anterior ın in the posterior papillæ of the tongue, because they inclose pro-rtionally more mucous tissue.*

§ 2085. Behind the lenticular papillæ, the surface of the tongue smooth, presenting only numerous muciparous glands; its sides are o smooth. We only remark on the limit between them and the ver part of the cavity of the mouth, the orifices of the excretory nals of the submaxillary gland.

2086. The tongue is covered in every part, especially on its upper e, by a thick, whitish and moist epidermis, (*periglottis*),† which is med exactly like the papillary tissue, and which consequently pre-ıts on its upper face numerous elevations, and on its lower face, ich looks towards the papillæ, a corresponding number of rounded pressions, so that at first glance it seems perforated with foramina, hough this is not the case.

§ 2087. We have already described the nerves of the tongue, and ve given our reasons for thinking the lingual twig of the fifth pair the principal conductor of the sensations of taste, while the hypo-ossal nerve should be considered as only the nerve of motion.

Although the tongue receives many nerves, and although its sur-e is very sensible, its substance is but slightly so. This explains w it can be very much bruised, or how considerable portions of it ıy be tied, without giving rise to general nervous affections.‡

§ 2088. The tongue is the principal organ of taste; it acts also in iculation, and contributes to the first changes of the food in the mentary canal.

The faculty of taste resides principally at its point, next on its ges, finally at its base, and very slightly or not at all in its centre. It wever is not the only organ of taste, for the soft palate is sensible, least to certain tastes, for instance that of bitter substances. Hence y the loss of the tongue is not necessarily attended with that taste.

The tongue assists also in articulation, inasmuch as several conso-nts, hence termed *lingual*, are formed, or at least articulated more tinctly, by its motions in different directions.

It also contributes to change the food in the mouth by carrying it different parts of this cavity, so that it becomes perfectly moistened h the saliva, and also prevents its escape from the mouth.

We shall return to this use of the tongue, and shall mention its rt in deglutition when describing the pharynx

Albinus, *De fabrica papillarum linguæ humanæ*; in the *Annot. acad.* l. i. c. tab. 1.—Hewson (*Exp. Inq.*, vol. ii. p. 186.—Sœmmerring, *loc. cit.* tab. 1., 5-9.

Albinus, *De periglottide et corpore reticulari linguæ*; in the *Annot. acad.* l. i. vi.

E. Home, *Obs. on the structure of the tongue, illustrated by cases in which ortion of that organ had been removed by ligature*; in the *Phil. tr.* 1805. p. —214.

§ 2089. The changes in the tongue during its development are trifling. At first its proportional volume is greater than when the organism is perfect. It is also broader, and is attached to the lower wall of the cavity of the mouth in a smaller portion of its lower face, which resembles to a certain extent the peculiar formation of frogs.

B. ABNORMAL STATE.

§ 2090. Sometimes the tongue does not exist, either from primitive deviations of formation, or from ulcers which have destroyed it.

Its frenum is not unfrequently too solid, too short, or too long. It is rarely bifurcated at its point.

The lenticular papillæ also are rarely entirely deficient, and replaced only by skin destitute of papillæ *

The excess in the size of the tongue is rarely congenital. It is observed more frequently during life after some accident, particularly from metastasis.

In this case a portion of the organ may be extirpated without inconvenience. This phenomenon seems to affect females more frequently than males.

The turning of the tongue backward, which produces suffocation by closing the entrance of the larynx, may be caused by its frenum being entirely divided.†

The principal alterations of the texture of the tongue are scirrhus and cancer.

IV. ORAL GLANDS.

A. ABNORMAL STATE.

§ 2091. The *oral glands (Gl. orales)* are of two kinds, the *muciparous* and the *salivary* glands.

a. Muciparous Glands.

§ 2092. The *muciparous* glands are distinguished into the *anterior* and the *posterior.*

The *anterior* are more insulated and lenticular. Their greatest diameter is only two lines, and they are found principally in the lips and cheeks, opposite the upper posterior molar teeth, between the buccal membrane and the muscles it covers. They are divided ac-

* Louis, *Mémoire physiologique et pathologique sur la langue*: in the *Mém. de l'ac. de chir* vol. v., p. 486-520.—Breidenstein, *De morbis linguæ*, Erlangen, 1791.

† We doubt whether death is ever produced by this cause, although travellers often speak of negroes swallowing their tongues. Superficial observers have been led into error by a phenomenon which is proved possible by Bourdon's researches, in giving reason to think, that the greatest effort in a robust person would cause death, and thus in some measure one commit suicide. (*Recherches sur le mecanisme de la respiration et sur la circulation du sang*, Paris, 1820, p. 81.)

ding to their situation into *labial*, *buccal*, and *molar* (*gl. labiales*, *cales et molares*). These latter are rarely blended in one mass, e excretory passages of which unite in one.

The *posterior* are the *palatine* glands and the *amygdalæ*.

The *palatine* glands (*gl. palatinæ*) form a continuous layer from e to two lines thick, which covers all the palatine arch and all the t palate, the posterior face of which they occupy.

The *amygdalæ* or the *tonsils* (*Amygdalæ*, s. *tonsillæ*) are oval bodies, out six lines long, three thick and broad, which exist in the soft ate between the anterior and posterior arches. The fluid they rete enters the cavity of the mouth through several broad openrs, situated on their anterior face.

b. Salivary Glands.

§ 2093. The three *oral salivary glands* (*gl. salivales orales*) which ong to the class of conglomerate glands* are situated around the ity of the mouth and near the lower jaw. They are the *parotid*, *submaxillary*, and the *sublingual* glands. All secrete a peculiar d, the *saliva*,† which is one of the most aqueous fluids of the body, l contains a peculiar principle which cannot be coagulated by ting, by tannin, or by the acetate of lead. We also find in it a te mucous substance, and the common salts of the serum of the od. It is also remarkable for its great affinity for oxygen.‡

Beside the general characters of the class to which they belong, se glands also present several common peculiarities, the principal which are as follow: 1. Their rounded form. 2. Their reddish our. 3. They have no special membranous capsule, are surunded only by condensed cellular tissue, and are loosely attached he adjacent parts. 4. They are so situated that they are affected the mechanical action of the muscles, and even partly by that of lower jaw when it is moved. 5. The fluid they secrete possesses bably in every part the same properties.

Notwithstanding these general points of resemblance, they differ much in form, size, texture, situation, and colour, that we must cribe each of them separately.

N. Stenon, *De glandulis oris et nuper observatis inde prodeuntibus vasis*, den, 1661.—A. Nuck, *Sialographia ductuum aquosorum anatome nova*, Leyden,). J. B. Siebold, *Historia Systematis salivalis physiologice et pathologice conrati*, Jena, 1797.

i. T. Fischer, *Diss. de saliva physiologice et pathologice considerata*, Breslau,

Berzelius, *Fortscritte der thierischen Chemie*, Nuremberg, 1815, p. 47.—John, *erches chimiques sur la salive et la liqueur que les ventricules de cerveau rennent dans l'hydrocéphale*; in the *Journ. compl. des sc. méd.*, vol. vi., p. 270.

a. Parotid gland.

§ 2094. The *parotid* gland (*parotis*),* is the largest oral salivary gland, and in the adult it usually weighs from four to five drachms.

Its form is irregularly square. It is usually more high than broad, narrower from within outward than in any other direction, and its thickness is much less than its height and breadth. Its lower half is considerably thicker and broader than the upper.

It is situated directly under the skin, before the lower half of the external ear, between the space in the ascending ramus of the lower maxillary bone forward, and backward between the auditory foramen and the mastoid process of the temporal bone.

Its upper extremity, which is also the smallest edge, extends to the posterior extremity of the zygomatic arch, and covers the head of the ascending ramus of the lower maxillary bone. Its smaller anterior half corresponds in its whole extent to the posterior part of the ascending ramus of the lower maxillary bone and of the masseter muscle. The posterior half is larger than the preceding, and fills the space we have mentioned. It covers the petrous portion and the styloid process of the temporal bone, also the external parts of the pterygoidei muscles and the upper part of those which arise from the styloid process. Posteriorly, the gland terminates by nearly a straight edge, which is, however, slightly grooved anteriorly. Its lower extremity descends below the angle of the lower jaw; it is in contact with the posterior part of the submaxillary gland, and with the middle tendon of the digastricus muscle.

The lower straight edge descends obliquely, covers the posterior belly of the digastricus muscle, and also generally a small portion of the upper extremity of the sterno-cleido-mastoideus muscle.

The posterior concave edge is adapted to the lower part of the cartilaginous portion of the auditory passage.

The parotid gland is formed of small, rounded, and distinct granulations.

At about the upper extremity of the middle third of its anterior edge an excretory duct emerges, called the *canal of Steno* (*ductus Stenonianus*).† The parietes of this passage are considerably thick in proportion to its capacity, and it proceeds from behind forward and from

* Murat, *La glande parotide considéré dans ses rapports anatomiques et pathologiques*, Paris, 1803.

†Although this term is generally applied to the parotid canal, it is not certain that it was discovered by Steno, and not by Needham or Blaes.—N. Steno, *Diss. de glandulis oris et nuper observatis inde prodeuntibus vasis*, Leyden, 1661.—Id., *Observ. anat. quibus varia oris, oculorum et narium vasa describuntur, novique salivæ lacrymarumque et muci fontes deteguntur et novum Bilsii commentum rejicitur*, Leyden, 1662.—Needham, *De formatu fœtu*, London, 1667; in the preface.—G. Blaes, *Misc. an. hom. brutorumque fabricam diversam exhibentia*, Amsterdam, 1673.

thout inward directly under the skin and on the masseter muscle. is generally from three to five lines distant from the lower edge of e zygomatic process. The transverse facial artery and some twigs the facial nerve accompany it. It passes on the anterior edge of e masseter muscle, penetrates between the fibres of the buccinator iscle, and opens in the lateral walls of the cavity of the mouth posite the first posterior molar tooth of the upper jaw, consequently fore the range of the teeth. Its orifice is single, and presents a irty prominence.

We not unfrequently find an *accessory parotid gland* (*Gl. parotis cessoria*), situated more or less before the normal parotid gland, on e malar bone and the zygomatic arch. This gland never communi-tes with the proper parotid gland, and sometimes divides into two oes; it opens by a small passage into the parotid canal. It may be mpared with the orbitar gland of several mammalia.

b. Submaxillary gland.

§ 2095. The *submaxillary* gland (*Gl. maxillaris*, s. *submaxillaris*)* but half the size of the parotid gland. It has the form of a rounded iangle. It is thicker below than above, and is situated on a level ith the angle of the lower jaw, between its inner face and the body the hyoid bone.

On the outside it touches the lower part of the inner face of the erygoideus internus muscle. Forward it sends a small prolonga-on above the posterior edge and the posterior part of the lower face the mylo-glossus muscle. It rests inward on the posterior extre-ity of the anterior belly of the digastricus muscle, posteriorly on the ylo-glossus muscle.

Although this gland is much smaller than the preceding, it is, how-ver, composed of much larger lobes.

The excretory duct, called the *canal of Wharton* (*ductus Wharton-nus*), arises from the anterior extremity; its parietes are very thin in roportion to its diameter, and it is larger compared with the size of the land than the duct of Steno. Its direction is obliquely from with-it inward and from behind forward; it passes above the mylo-glos-is muscle, below and on the inside of the submaxillary gland, on the utside of the upper edge of the hyo-glossus muscle, and terminates y a small verrucous prominence on the sides of the frenum of the ongue, consequently behind the range of the lower teeth.

Farther inward the substance of the gland sends off a prolongation ome lines thick, which follows the same direction, but does not extend high, passes through the inner part of the posterior extremity of the

* Wharton, *Adenographia*, ch. xxi.—Van Horne, *De ductibus salivalibus disp. II.*, 1656, 1658.

sublingual gland, and opens at the side of the canal of Wharton, sometimes in common with a small excretory duct which leaves this latter gland. This common duct is called the *canal of Bartholini* (*ductus Bartholinianus*).*

c. Sublingual gland.

§ 2096. The *sublingual gland* (*Gl. lingualis*, s. *sublingualis*)† is situated before the preceding, so that the posterior extremity touches the anterior extremity of the latter, occupies on each side the whole length of the tongue, and may be found directly under the buccal membrane, through which it is easily felt, and is even visible, on account of its inequalities and prominences. It is situated between this membrane, the myo-glossus, the genio-glossus, the genio-hyoideus, and the hyoglossus muscles. It is formed like an elongated triangle, and it is nearly as large as the submaxillary gland.

It is composed of smaller lobes than the preceding, is whiter and harder than it, and opens not like the two glands previously described by one orifice, but by several, usually seven or eight; it, however, forms no distinct excretory duct. We perceive these openings on the lower face of the cavity of the mouth on each side below and near the tongue. There are also several ducts from its anterior portion (*ductus Riviniani*), which unite with that of the submaxillary gland; sometimes one only anastomoses with a passage formed by a division of this latter, and thus give rise to the passage of Bartholini (§ 2095).

§ 2097. There are in fact no other salivary glands or other passages which carry saliva. Although several anatomists‡ have admitted others, it has long been proved that the parts considered as such are simply those of the muciparous glands at the root of the tongue or around the larynx, or even of the veins of the back of the tongue.§

§ 2098. The oral glands present no differences in respect to their development, except those generally remarked in all glands.

* G. Bartholini has discovered it in the lion (*De ductu salivali hactenus non descripto observatio*, Leyden, 1684).

† A. F. Walther, *De lingua humana novis inventis octo sublingualibus salivæviis, nunc ex suis functionibus, glandulis sublingualibus eductis*, Leipsic, 1724.—C. J. Trew, *De vasis linguæ salivalibus atque sanguiferis epistola*, Nuremburg, 1734.

‡ A. Vater, *Novus ductus salivalis, qui in linguæ superficie superiore circa ejus medium notabili orificio hiat*, Wittemberg, 1720.—Id., *Novus ductus salivalis isque præcipuus in lingua excretorius glandulæ insignis ad latera linguæ et sub eadem sitæ itemque super radicem linguæ, epiglottidem, circa glottidem super arytænoideas usque intra œsophagum expansæ*, Wittemberg, 1721.—Id., *De ductu salivali in lingua noviter antehac detecto, nunc dilucidato, confirmato, novisque experimentis adducto, una ductus excretorius tonsillarum ac glandulæ thyreoideæ*, Wittemberg, 1723.—G. D. Coschwitz, *De ductu salivali novo*, Halle, 1724.—Id., *Continuatio observationum de ductu salivali*, Halle, 1729.

§ Trew, *loc. cit.*

B. ABNORMAL STATE.

§ 2099. The anomalies of the oral glands, generally speaking, pre-
nt nothing peculiar.
Primitive deviations of formation are very rare.
We must, however, mention as such the abnormal union of the
rotid and submaxillary glands.
These organs, particularly the parotid canal, are easily wounded;
s causes the saliva to flow outward, and thus forms salivary fistula.
The closing of the orifice of the excretory canal of the submaxillary
nd is often at least the cause of *ranula*, although this affection
ends very frequently on a newly-formed cyst.*
Simple enlargement is rare. The swelling of the parotid gland
nflammation is situated in the cellular tissue between its lobes.
So too the general alterations of texture, as scirrhus and cancer,
ch are also attended with an increase of volume, generally occur
in the glandular tissue, but in the lymphatic glands, which are
ated on the inside and below the salivary glands, since the glan-
ar tissue is generally unaffected in this case.†
The tumors developed in the lower jaw are also situated in the
phatic glands of the neck. Sometimes we meet here, as in other
s of the system, accidental ossifications with formations entirely
ormal.‡
alculous concretions are formed in the amygdalæ and the salivary
ages, especially in the excretory ducts of the submaxillary gland.
se calculi are composed according to Fourcroy,§ of an animal
ter and of phosphate of lime. If however we may judge from
rnal characters, a salivary calculus described by us|| seems more
lar to those biliary concretions which have cholesterine for their
.
he calculi developed in the amygdalæ are of a dirty white colour.
disagreeable odour which they generally possess probably de-
is,¶ at least in great part, on the decomposition of animal
er which surrounds them and enters into their composition; for
iently this matter alone is very disagreeble, and like the forma-

Breschet, *Considérations sur la tumeur nommée communément ranule ou uillette*; in the *Journ. univ. des sc. méd.*, vol. viii., p. 296.
Burns, *Anatomy of the head and neck*, p. 270.
Burns, *loc. cit.*, p. 283.
yst. des. conn. chim., vol. ix., p. 312.—John has found nothing else in two iry calculi, one of which come from the tissue of the parotid glands: *Che-e Zerlegung einer Concretion der Parotis*; in the *Deutsches Arch. für die ologie*, vol. iv., p. 602: *Chemische Zerlegung einer Speichelsteins*; same al, vol. vi., p. 603.
Handbuch der pathologischen Anatomie, vol. ii., pt. ii., p. 467.
Burns, *loc. cit.*, p. 265.

tion of the calculi of which we are speaking,* depends on a derangement of the digestive function.

V. TEETH.

§ 2100. The teeth (*dentes*)† are the hardest parts of the body. In their chemical and physical properties they resemble the bones, but they differ from them in their mode of union with the body, in their mode of development, and in their vital phenomena. In all these respects they are more similar to the epidermoid parts, particularly the nails and hairs.

A. NORMAL STATE.

a. Perfect state.

§ 2101. 1st. *Situation.* The teeth are inserted in most of their extent in the alveolar processes of the two jaws, which closely embrace them, and articulate with them by gomphosis. The portion in the alveolar process is termed the *root* (*radix dentis*). The rest of the tooth is not free. The centre, which is the smallest part, is termed the *neck* (*collum*, s. *corona dentis*), and is surrounded by the gum; all the portion above projects, and is exposed in the cavity of the mouth; this is the *body* or *crown* of the tooth (*corpus*, s. *corona dentis*).

* Burns, *loc. cit*, p. 265.

† Treatises on the teeth generally treat of their anatomy, physiology, pathology, and therapeutics, and differ only by speaking more at length on one of these heads. We mention several works almost entirely pathological, as many of them contain a number of special or general remarks in regard to their anatomy and physiology: Eustachius, *De dentibus libellus*, Venice, 1563.—B. Martin, *Dissertation sur les dents*, Paris, 1679.—A. C. G. Cumme, *Diss. sist. dentium historiam*, Helmstadt, 1715.—P. Fauchard, *Le chirurgien dentiste, ou traité des dents*, Paris, 1728.—Lecluse, *Nouveaux élémens d'odontologie*, Paris, 1754.—Bourdet, *Recherches et observations sur toutes les parties de l'art du dentiste*, Paris, 1757.—Curtis, *A treatise on the structure and formation of the teeth*, Oxford, 1769.—F. X. de Wasserberg, *Aphorismi anatomico-physiologici de dentibus*, Vienna, 1770.—J. Hunter, *Natural history of the human teeth*, London, 1778.—H. G. Courtois, *Le dentiste observateur*, Paris, 1775.—Broussonet, *Considérations sur les dents en général et sur les organes qui en tiennent lieu*; in the *Mém. de l'ac. des sc.*, 1787, p. 550.—A. G. Berger, *Diss. de dentibus*, Kiel, 1788.—S. H. Bring, *Observationes in hodiernam de dentibus, præcipue hominum, doctrinam*, Lund. 1793.—F. Hirsch, *Praktische Bemerkungen über die Zahne*, Jena, 1801.—R. Blake, *Essay on the structure and formation of the teeth in man and various animals*, Dublin, 1801.—J. Fox, *Hist. nat. et maladies des dents de l'esp. humaine*, Paris, 1821.—A. Serres, *Essai sur l'anatomie et la physiologie des dents, ou nouvelle théorie de la dentition*, Paris, 1817.—F. Lavagna, *Esperienze e riflessioni sopra la carie dei denti*, Genes, 1821.—Heilbronn, *Diss. de dentibus*, Berlin, 1821.—C. G. Kaathover, *De dentium formatione atque natura*, Leyden, 1821.—J. Lemaire, *Traité sur les dents*, Paris, 1822.

The root and neck of the teeth are covered with a thin membrane ; s is continuous below with a nervous and vascular tissue which s the cavity of the tooth, and above with the gum; it is termed the *ular periosteum*, although the history of dentition seems to demonate that its relations with the teeth are not the same as those beeen the periosteum and the bones.

The alveolar processes are also covered by a fibrous and thick memne, which in the normal state does not unite with the preceding, : is continuous with the upper part of the gum, and is termed the *veolar periosteum.*

The *gums* (*gengivæ*) are a firm, resisting cellular tissue about half ine thick, which adhere intimately with the buccal membrane, and eive but few vessels or nerves. They cover the neck of the th, and also the two faces of the alveolar edges of the jaws, and nish thin prolongations which extend between each two teeth, m the anterior to the posterior face.

The teeth of each jaw collectively form an arch which is concave ckward and convex forward.

They are generally arranged very compactly, and are placed at ual distances from each other. The upper and the lower touch at eir summits. The arch formed by the upper teeth is a little longer n the other. Hence the upper teeth slightly project outward, and : anterior, which are thinner, cover the others. The posterior and erior teeth have their summits slightly inclined inward, while those the upper are turned more directly downward.

2d. *Form.* All the teeth are more or less elongated ; their lower exmity is slightly pointed, and there presents a small opening which ds into the *cavity of the tooth* (*cavum dentis*). This cavity extends n the summit of the roots to the crown, and is very narrow in portion to its length, represents the form of the tooth, and lodges vessels and nerves, which are connected by cellular substance.

3d. *Number.* The number of the teeth is the same in the two jaws, the two sides, and in the two sexes. In a well developed man re are thirty-two.

4th. *Texture.* The tissue of the teeth is very hard and solid. They composed of two substances, the *osseous substance* and the *amel.*

§ 2102. The *osseous substance* or the *ivory* forms the largest part of : tooth, the root, the neck, and almost all the crown. It consently represents the form of the whole tooth. Its hardness, which ceeds that of the bones, depends upon its mechanical arrangement d on its chemical composition. In fact it contains no cellules. e perceive in it but not very clearly only longitudinal layers, uated one upon another from without inward, and it contains ore of lime than the other bones. Berzelius asserts* "that one

* Gehlen, *Journ. fur die Chimie und Phys.*, vol. iii., part i., p. 19.

hundred parts of this substance contain 51.01 of phosphate of lime; 2.00 of fluate of lime; 11.30 of carbonate of lime; 1.16 of phosphate of magnesia; 1.20 of soda; and an indeterminate quantity of hydrochlorate of soda. Pepys states that they contain 0.61 of phosphate of lime; 0.6 of the carbonate; 0.20 of gelatine; and 0.10 of water, including the loss.*

§ 2103. The *enamel* (*substantia vitrea*)† is milk white, brilliant, semitransparent, and still harder and firmer than the osseous substance. It covers all the crown of the tooth, is moulded exactly upon it, and preserves all the inequalities of its masticating surface, where it is thickest. It gradually grows thinner towards the neck. It is composed of oblique, undulating, serrated bands, concave upward, convex downward, which are arranged compactly from above downward, and exactly fit to each other.‡

The enamel contains still more of earthy salts than the osseous substance. We find in it, according to Morichini: § 0.33 of lime; 0.09 of magnesia; 0.05 of alumina; 0.22 of fluoric and phosphoric acids; 0.01 of carbonic acid; and 0.30 of animal substance.

According to Hatchett ‖ it contains very little of gelatine, and is mostly formed of phosphate of lime.

Foucroy and Vauquelin ¶ state that it is composed of 72.90 of phosphate of lime, and 27.10 of gelatine and water.

Pepys asserts ** that it is formed of 0.78 of phosphate of lime; 0.60 of the carbonate; and 0.16 of water.

Finally, Berzelius †† mentions as its component parts: 85.3 of the phosphate; 3.3 of the fluate; 8.0 of the carbonate of lime; 1.5 of the phosphate of magnesia; and 2.0 of animal substance and water.

§ 2104. The vessels and nerves of the teeth are proportionally very large. The first arise from the internal maxillary artery; the nerves come from the second and third branch of the trifacial nerve, penetrate through the openings at the summit of the roots, correspond perfectly to them in number, descends into the cavity of the tooth, where, united by cellular tissue, they form the *nucleus* or *pulp of the tooth* (*pulpa*, s. *nucleus*). These nerves enlarge near the neck of the

* Fox, *loc. cit.*

† Ludwig, *De cortice dentium*, Leipsic, 1753.—Schreger, *Uber den Zahnschmelz*; in Rosenmuller and Isenflamm, *Beyträge zur Zergliederungskunst*, vol. i., part i.

‡ Cumme, *loc. cit.*, p. 9.—Schreger. *loc. cit.*

§ *Analisi dello smalto di un dente di elefante e dei denti umani*; in the *Memoire della societa italiana*, vol. x., pt. i., p. 162; vol. xii., pt, ii., p. 73.

‖ *Phil. trans.*, 1799.

¶ *Mém. de l'Institut.*, vol. ii., p. 283.—*Annales de Chim.*, vol. lv., p. 265; vol. lvii., p. 37.

** *Loc. cit.*

†† Gehlen, *Journ. fur phys. und Chem.*, vol. iii., part i., p. 27.

ooth, become soft and reddish, and seem covered with network of essels.*

§ 2105. These characters are common to all the teeth; but there re others in respect to which they differ, and hence they may be ivided into several classes.

They differ from each other in several respects, but principally in egard to:

1st. Their situation.
2nd. Their form.
3rd. Their duration.
4th. The period of life at which they appear.

§ 2106. In respect to *situation*, the most general difference is that hich exists between the teeth of the upper and those of the lower aw. The latter differ from the former in being a little smaller, so hat the curve represented by their union is narrower and shorter; ence the upper row of teeth projects a little beyond the lower in very part.

§ 2107. The teeth of the same jaw differ from each other in *form;* ence their division into three classes, the *incisors*, the *canine*, and he *molar* teeth.

§ 2108. The *incisors* (*dentes incisivi, incisores, primores*) are eight n number, four in each jaw, occupying the most internal and the ost anterior part. They differ most from the others in the form of eir crown. The latter is chisel-shaped, and becomes much thinner from the neck to the summit, which presents the cutting surface. he posterior face is very concave and the anterior is convex, but ot in the same proportion. The incisors begin to become extremely in from their centres. In the perfect state, when they have not een used for mastication, their edge is divided into a middle and vo lateral small grooves; but these grooves soon disappear, and the ummit of the tooth then forms only a thin straight line, which extends the whole breadth of the crown.

These teeth have but one root. It diminishes imperceptibly from ie crown to its extremity. A depression not unfrequently exists s whole length on each side, indicating the division of this root ito two halves, an anterior and a posterior; and even the summit divided into two small grooves, an anterior and a posterior.

The incisors differ from the other teeth in their direction; they re situated more transversely, so that their loose face looks forward; ie other is turned backward, and their cutting edge extends from ne side to the other.

§ 2109. The incisors also differ much from each other. The difrence between the syonymous teeth of the two jaws is no where striking as in them, even when they are most similar in size. hose of the upper jaw, however, extend half a tooth farther outward

* Serres, *loc. cit.*, p. 52.

than those of the lower jaw. The superior are twice as large as the inferior.

The incisors of the lower jaw differ also from the others both in size and form. In fact they all have a chisel-like form, and their external edge is about as high as their internal. Sometimes, even, they are all similar in this respect. But most commonly their external edge descends a little lower than the internal, and is continuous with the other by a rounded angle.

The internal inferior incisors possess this form very seldom, and the others very generally. In the external superior incisors the internal edge is a little convex outwardly, and is insensibly continuous with the lower, although a little farther downward, so that the cutting surface is narrower than the greatest breadth of the tooth.

These differences in form deserve notice, as they establish the gradual transition from the internal inferior incisors to the canine teeth through the medium of the others.

In respect to the size, the inner pair of incisors in the upper jaw are a little and often much larger than the outer; while in the lower jaw the incisors are about the same size, or the outer pair is a little larger than the inner.

§ 2110. Next to the incisors come the four *canine* teeth (*dentes canini, ferini, cuspidati*), one on each side. Their crown is much thicker from before backward than that of the incisors, but it does not diminish as rapidly from above downward; hence why their summits are less cutting. This summit is also pointed, because the lower face does not describe a straight line, as the two lateral faces terminate higher than in the incisors, and as the crown of the canine teeth is as elevated as that of the latter, it follows that the lower face is composed of two parts which unite in the centre at an acute angle. Consequently the crown is more rounded and more conical; it extends both inward and outward above that of the incisors. On the posterior face we perceive from above downward in the centre a slight prominence, between which and the edges there is a small depression. This arrangement is more evident in the inferior than in the superior canine teeth.

Of all the teeth the canine have the longest roots. These roots are single and pointed. We generally observe in them the groove mentioned when speaking of the external incisors.

§ 2111. In the posterior part of the jaw are the twenty *molar teeth* (*dentes molares*), ten in each jaw, five on each side. They are similar to each other, and differ from the other teeth:

1st. In the greater breadth of their triturating surface, which depends on the fact that the posterior face of the crown does not descend obliquely to meet the anterior, but is parallel with it.

2d. In the square or rounded form of this surface generally.

3d. In the considerable elevations and depressions in this triturating surface.

4th. In the lowness of their crown.

5th. In the division of their roots into several distinct branches, at least they are much more distinct than any other teeth where is division is only indicated.

§ 2112. Notwithstanding this general similarity they differ very uch, particularly the two anterior and the three posterior. The st are termed the *small molar* or *bicuspid* teeth (*molares anteriores, minores*, s. *bicuspidati*), and the others, which are larger, the *eat molar* or *multicuspid* (*molares posteriores*, s. *majores*, s. *multi-spidati*).

§ 2113. The small molar teeth differ from the great:—

1st By their smallness. They are at least one half smaller.

2nd. By their compression from one side to the other.

3rd. By their triturating surface, which is less uneven.

4th. By the form of their roots. The latter are at most biscuspid, d even when they assume this form they are so only in the part rthest from their crown, that is, they never present as deep a sure as the posterior molar teeth. In most cases they are broader m within outward than those of the incisors and the canine teeth, e terminated by a blunter summit, and their lateral grooves are ore superficial.

The triturating surface of the small molar teeth generally presents o eminences, one anterior and external, the other posterior and ernal. From this they take their name. This arrangement is re evident in the upper jaw, because the two eminences are there parated by a deep transverse groove. In the lower jaw the emi-nces of the small molar teeth are, on the contrary, united by a st, the direction of which is from without inward. This difference serves notice, because the canine teeth of the two jaws (§ 2110) fer from each other in the same manner. The external anterior inence is always higher than the internal, particularly in the first all inferior molar tooth, where the internal is but slightly de-oped, and which, in these two respects, evidently makes the tran-ion from the canine to the other molar teeth.

But this is not true of the second small anterior molar tooth. In s we usually observe, behind the posterior eminence, a smaller l more prominent tubercle, or sometimes the posterior eminence is ided into two equal halves. At the same time the external is ver, the crown and the triturating surface are still more rounded, that this tooth evidently makes the transition from the anterior to posterior molar teeth; it is also a little larger than the internal.

The small superior molar teeth are more similar to the large than inferior are, on account of the greater development of their pos-ior tubercle.

§ 2114. The three posterior molar teeth generally present four blunt ercles, two on the outside, and two on the inside, which are sepa-ed by a crucial depression. But we usually observe also between posterior two, on the edge of the triturating surface, a fifth, which

is smaller. These tubercles are also rough. The external prominences are generally the largest and most numerous, and frequently the internal tubercle is single, especially in the last two molar teeth. The last great molar tooth is usually the smallest, and the first the largest.

Most generally the roots of these molar teeth present three branches, into which they frequently divide near their crown. The last, it is true, generally has but one root, but this root is never as pointed as in the canine teeth and the incisors, and it always presents at least two very deep and very broad grooves, which indicate a tendency to divide. Sometimes also the other two great molar teeth have only two branches at their root; but in this case one of the branches is always much broader than the other, and also presents a broad and deep groove. In some subjects this broad unmated branch bifurcates below into two small points. The branches of the roots of the molar teeth are usually more curved than the simple roots of the incisors and canine teeth; they begin by separating from each other; they then converge more or less at their lower extremity, where they even touch each other, and blend together at their summits, so that they intercept between them a portion of the upper maxillary bone.

§ 2115. The characters which we have mentioned are those by which we distinguish the teeth which remain in the jaws during most of life. But there are other different teeth which exist but a short time, in youth, and are termed the *deciduous*, or *milk teeth* (*dentes decidui*, s. *infantiles*, s. *lactei*), in opposition to the first, which are termed the *permanent* teeth (*dentes permanentes*).

The teeth which appear at first do not continue during life; many of them remain only till the seventh year, and at the fourteenth year all are replaced by new permanent corresponding teeth.

§ 2116. The two classes of teeth differ from each other in number and form.

In the first respect, we ought not to find more than two molar teeth in each half of the jaw, during the period of the deciduous teeth, whence there are only twenty deciduous teeth, while there are thirty-two permanent teeth.

In respect to form, we distinguish also among the deciduous teeth, the incisors, the canine, and the molar teeth. The incisors and the canine teeth resemble the permanent teeth in form, number, and situation; but all the deciduous teeth, and particularly the molar teeth, differ from their corresponding permanent teeth.

1st. Their crown is much stronger in proportion to their root.

2nd. They are less elevated.

All do not present the same peculiarities in respect to size. The deciduous incisors and canine teeth are much smaller than the permanent teeth, particularly in the lower jaw. The contrary occurs in the molar teeth; they come immediately after the canine teeth, the two small anterior molar teeth replace them, and the three molar teeth

behind them are permanent. Hence the small anterior molar teeth among the permanent teeth are those which correspond to the deciduous molar teeth at least in respect to situation. But the latter are much larger; they have not the same form as the small permanent molar teeth, for instead of being flattened from before backward, they are extremely broad, have a broad square crown, and also several, usually five tubercles, which are arranged around a very deep median groove. The anterior is nearly one half smaller than the posterior, although the posterior is almost as large as the largest of the permanent teeth. Besides, they have always at least two and usually three roots. Thus they correspond to the permanent small molar teeth only in number and situation, for in respect to size and form, that is, in two respects much more important than the two preceding, they are analogous to the three permanent great molar teeth.

b. Differences depending on development.*

a. General remarks.

§ 2117. The teeth pass through several periods, during which perhaps they differ more than any other part of the body.

The history of their development presents several very curious phenomena. The most essential points to consider are their mode of development, the period at which they appear, and their changes during life.

1st. The teeth are developed in small rounded and close sacs, which adhere very closely to the gums. These sacs are composed of two membranes. Hunter thinks that the internal alone is vascular,

* Besides the works mentioned previously, which also treat on this subject, we may consult the following: J. J. Rau, *De ortu et generatione dentium*, Leyden, 1694.—J. A. Ungebauer, *De dentitione secundâ*; in Haller, *Coll. diss.*, vol. vi.—J. G. Jancke, *De ossibus mandibularum puerorum septennium*, Leipsic, 1751.—B. S. Albinus, *De dentium ortu et incremento*; in *Annot. acad.*, vol. ii. ch. ii., *Quot dentes mutet puer, et quos*, ibid., ch. iii., *De dentium mutatione*, ibid., ch. i.—Jourdain, *Essai sur la formation des dentes comparée avec celle des os, suivi de plusieurs expériences sur les os et sur les parties qui entrent dans leur composition*, Paris, 1766.—A. A. Brunner, *De eruptione dentium lacteorum*; in Wasserberg, *Opp. min., fasc. I*, Francfort, 1775.—M. Girardi, *De re anatomicâ oratio*, Parma, 1781, tab. i.—Andrée, *De primâ puerorum dentitione*, Leipsic, 1790.—Léveillé, *Mémoire sur les rapports qui existent entre les premières et les secondes dents, et sur la disposition favorable de ces dernières au développement des deux mâchoires*; in the *Mém. de la soc. méd. d'Emul.*, vol. viii., Paris, 1811.—Miel, *Quelques idées sur le rapport des deux dentitions et sur l'accroissement de la mâchoires dans l'homme*; same journal.—Duval, *Mémoire sur la position relative de l'ouverture externe du canal maxillaire, pour servir à la démonstration de l'accroissement de la mâchoire inférieure*, Paris, 1812.—J. F. Meckel, *Essai sur le développement des dents chez l'homme*; in the *Journ. compl. des sc. méd.*, vol. i, p. 365.—Miel, *Note sur la manière dont les dents sortent des alvéoles et traversent les gencives*; in the *Journ. de méd.*, vol. xxxix. p. 235.—J. E. Oudet, *Observation d'une altération de la racine d'une dent canine, présentant les caractères extérieurs de la maladie des os, connue sous le nom de spinu ventosa, précédée de quelques considérations générales sur la phys. dentaire*; in the *Archiv. gén, de méd.*, vol. i., p. 310.—Geoffroy Saint Hilaire, *Système dentaire des mammifères et des oisseaux, embrassant sous de nouveaux rapports les principaux faits de l'organisation dentaires chez l'homme*, Paris, 1824.

while Black admits this only of the external. But we have ascertained from examining the human fœtus, and those of animals, and Fox has also determined that these two membranes receive vessels; the blood, however, seems to flow more abundantly to the external than to the internal. A serous fluid exists between these two layers, and the distance between them is much greater the younger the fœtus is, although the layers themselves are more difficult to demonstrate than in fœtuses of a certain age, on account of their extreme smallness.

The external layer is more spongy, looser, thicker, and softer, than the internal. It is very distinctly continuous with the gum, whence it is easy, in the fœtus, especially during the early months of pregnancy, to extract the alveoli attached to the gum.

The internal layer is harder, but thinner than the external. We can demonstrate that it forms a sac entirely distinct from the external and from the gum. Its relations with the teeth are more intimate than those of the external layer, for it is the proper organ of formation. The vessels of the teeth are distributed there much more evidently, and when injections succeed, it appears entirely red.

2nd. The small sacs or follicles appear very early. About the tenth week we observe very distinctly in each half of the two jaws, four, two anterior which are smaller, and two posterior which are larger; they are arranged very compactly in pairs, but the anterior and the posterior are separated by a considerable space. At the end of the third month we find a third sac between the two pairs, and thus at this period the whole number of follicles is twenty. We generally discover at the end of the fourth month, a sixth, situated entirely backward, and which is destined for the most anterior permanent molar teeth.

3rd. At first these small sacs contain only a reddish fluid, which afterwards becomes yellowish white. After a certain time, at the fourth month of pregnancy, a small reddish and soft body rises from the base of the internal membrane; this gradually becomes more consistent, and forms the *germ* or *pulp* of the tooth (*pulpus dentis*). Numerous vessels and nerves given off from the base of the inner membrane, are distributed in this small body, which seems to be enveloped by a vascular membrane, which is difficult to be detached from its own proper substance. It is at first very low, is single in every part, and terminated by a rounded summit; but it soon assumes the peculiar form of each kind of tooth, and presents its exact image, and is, in fact, the nucleus around which the tooth is moulded. The latter is so developed that the loose portion appears first, and presents all the depressions and the eminences which exist upon it, while the rest is not yet formed.

The teeth begin to ossify about the middle of pregnancy. On the loose face of the germ very delicate, thin, and elastic small points first appear; these are primitively soft, but gradually become thicker and more consistent. These points are grooved and very slightly

elevated.' They are seen first on the most prominent part of the germ, and represent the tubercles of the future tooth. One is developed on each prominence of the pulp of the tooth; they gradually unite with each other; they begin to develop themselves only when a portion of the region of the germ corresponding to the crown is formed, and embrace that part of the pulp, which they cover so closely that some exertion is necessary to separate them. Their internal face and the external face of the germ are, however, perfectly smooth. The difficulty in separating them depends only on the exact manner in which they are fitted to the latter, since by removing one scale, we can extract the whole germ through the space thus formed. Hence, it is very probable that there is no organic attachment between the pulp and the osseous substance, so that these two parts of the tooth are united by vessels, by cellular tissue, or by some other analogous substance. But it is very curious that the germ is redder in the parts covered by the osseous substance, and that the progress of this redness is in direct ratio with that of ossification.

The points soon enlarge, so that they are much thicker in the parts first developed, that is, on the triturating surface. They become much thinner posteriorly, where they are much softer. The crown gradually enlarges, and its development is finally completed. Its lower extremity contracts and becomes the neck of the tooth. The roots are prolongations of the crown, in forming which the germ follows precisely the same course as in giving rise to the latter. The number of the roots, even when the germ has formed only the crown of the tooth, is indicated by that of the distinct branches given off by its vessels.

The osseous substance forms from without inward, so that the small tubercles which first appear are also the parts which always remain exposed, and the triturating surface, like the existing portion of the tooth, has already its normal volume, while it is still very thin, and its internal cavity is very large. This phenomenon demonstrates, undoubtedly, that the bony portion of the tooth is not formed by the inner face of the capsule, but by the external face of the germ, since if this were not true, the opposite arrangement would exist. This osseous portion gradually thickness, and the pulp and the dental cavity diminish in the same ratio, although we cannot suppose that the germ ossifies.

Shortly after the development of the osseous points, or during their formation, the secretion of the enamel commences, by the inner face of the inner fold which surrounds the crown of the tooth, so as to be perfectly moulded upon its prominences and depressions. The fluid exhaled by this membrane deposits the enamel on the osseous substance, which is so soft, and adheres so slightly to this latter in the full grown fœtus, that they may be very easily separated. It can be detached also, even in the perfect state, from the influence of certain causes, among others, by the action of heat. We discover no special gland for its secretion. It may, however, be easily separated from the prolongations of the internal layer. These prolongations which arise

from the portion of the capsule attached to the germ, are at first very thick and moist; they gradually disappear as the enamel forms, so, that we may consider them as the germ of this production, and similar to that which arises from the bottom of the capsule to secrete the osseous substance of the tooth.

The different kinds of teeth do not ossify after the same type in respect to time and form. The internal incisors are the first, and the posterior molar teeth the last to appear. In regard to the intermediate teeth, the deciduous teeth differ from the permanent teeth. The incisors and the canine teeth arise by one small point, and the molar teeth by several, viz. the small by two, and the large by four or five. Each point always possesses a thin triangular form on its appearance, which is the constant form of the crown of the canine tooth. In the incisor and molar teeth these points extend, and those of the incisor teeth present two small accessory points, which do not arise by special nuclei. Among the different points of the canine teeth the external and the anterior are developed the first, and next the internal. In the large posterior molar teeth the anterior external is first seen, then the anterior internal, and the two points of the first posterior form in the same order. The different points unite according to the same law, so that judging from their development, the large molar teeth seem to be formed by two smaller teeth.

The inferior arise or are developed before the superior. The points of the anterior deciduous molar tooth are already united to the lower jaw in the full grown fœtus, while this is not the case in the upper jaw. In one case where the first inferior permanent molar tooth presented five osseous points, there were only three in the superior.

§ 2118. When is the formation of the tooth completed? It is not certainly known when it appears, since the tooth cuts through the gum before it is perfectly developed; but we have now to inquire if the tooth undergoes any other internal changes after the root is perfectly formed.

Those who maintain this fact adduce the following arguments :—

1st. The change in the tooth in animals fed with madder.

2nd. The projection of one tooth above the rest, when the corresponding tooth in the opposite jaw is extracted.

3rd. The union of fractured teeth.

The following arguments have been adduced in favour of the continual reproduction of the enamel :—

4th. The pathological changes in this substance, particularly the black spots, which do not reappear after being removed until a new disease supervenes*.

5th. The duration of the enamel, which cannot be explained when we consider the continual friction of the teeth, except by admitting it is constantly forming†.

* Hirsch, *loc. cit.*, p. 17.
† *Ibid.*

The following are objections to these different arguments:—

1st. The colouring of the bones generally by madder does not prove that their substance is constantly reproduced*.

2nd. Probably we have less right to admit an increase in the size of the tooth than its expulsion from the alveolar process. Beside the phenomenon to which it alludes does not occur in man or in most mammalia, although observed in some of them, particularly the gnawers†, the teeth of which project after being extracted or cut off.

3rd. The union of fractures of the teeth does not prove that their substance is continually reproduced, but only that in some cases the germ of the tooth can restore a fractured part by a process analogous to that, when at the commencement it secretes the osseous substance in every part.

4th. It is nowhere proved that the enamel is formed again in the pathological cases adduced.

5th. The duration of the enamel depends on its solidity.

Thus the arguments in support of the continual formation of the teeth in general, and particularly of the enamel, are by no means conclusive. On the contrary the second fact contradicts it. Beside the mode in which the enamel is developed does not admit this theory.

§ 2119. Beside the whole duration of pregnancy, a long time advances, usually six months after birth, before the teeth appear, at least externally.

During this period we find in the place afterward occupied by them, a very hard and in fact a cartilaginous mass, which projects and presents numerous grooves some lines deep and entirely different from the gum ; this arises above the surface of the alveolar edges and fulfils the function of the teeth, that is, it serves principally to retain the nipple.

This substance may be called the *dental cartilage* (*cartilago dentalis*). It is worthy of notice as analogous to the horny beak of birds and reptiles. It disappears as the teeth are developed and perforate the gum.

We discover in this substance, particularly in the region of the molar teeth and on its inner and concave side, several follicles of different sizes, containing a shining and yellowish substance; these are at most but half a line in diameter, and apparently have no external orifice. Serres first mentions these follicles‡. He thinks that they soften the gum of the child before the teeth appear, and afterwards secrete the tartar of the teeth. We, however, have never observed them until the period when the teeth appear, so that hitherto we have considered

* B. Gibson, *On the effect of madder-root on the bones of animals*; in the *Mem. of the literary society of Manchester, 2nd series*, vol. i., p. 146-164.

† Lavagna, *Osservaz. sulla carie dei denti*, Genoa, 1812.—Oudet, *Expériences sur l'accroissement continu et la reproduction des dents chez les lapins, considérées sous le rapport de leur application à l'étude de l'organisation des dents humaines*; in the *Journ. de phys. expér.*, vol. iv., p. 70.

‡ *Loc. cit.*, p, 28—33, pl, 4, f. 6.

them simply as new formations, caused by the irritation of the teeth which are soon to appear; they probably do not differ in their nature from abscesses.

§ 2120. The triturating surface of the permanent teeth, like that of the deciduous teeth, changes more or less during life. The enamel is gradually used by friction so that the osseous substance is exposed, and the triturating substance, formed at first entirely of enamel, presents only a layer of osseous substance when the cutting edges and the pointed summits of the crowns are blunted. When the tooth is still more worn, so that the osseous substance is destroyed to the dental cavity and the latter is open, there is generally formed in the same proportion at the summit of this cavity a brownish substance resembling bone, but a little softer, which closes the opening and protects the parts within the cavity.* These phenomena can also be adduced against the opinion of those who assert the continual reproduction of the enamel.

Nutrition, however, gradually declines in the teeth, and their nutritious foramina are finally obliterated. Being retained in the alveolar processes by no organic attachment, they become loose and fall out. The alveolar processes collapse and the alveolar edge entirely disappears after the gum has closed the alveolar openings.

b. Special remarks.

§ 2121. The different kinds of teeth do not pass through the different periods generally mentioned in the same time, but very irregularly and more or less in succession. We may mention generally:

1st. That they pass through the different periods after the same law, so that the germ of the tooth in which the follicle first appears is also the first to be developed and ossified.

2nd. That the synonymous teeth in the same jaw correspond very exactly in this respect.

3rd. That the lower teeth are developed before the upper, and the anterior before the posterior.

4th. That the gradual development of the human teeth corresponds to permament forms in the mammalia.

1. Deciduous teeth.

§ 2122. The deciduous teeth, in accordance with the first law, appear sooner than the permanent teeth. The period at which their follicles are developed, and the order in which these latter are seen,

* Hunter, *loc. cit.*, p. 108.—Prochaska, *Obs. de decremento centium*; in the *Annot. acad.*, *fasc. I.*

have already been mentioned above. The two internal follicles are those of the incisor teeth, and the external those of the molar teeth; the fifth intermediate is that of the canine tooth.

Ossification begins at the fifth month in the inner incisor teeth, a little sooner in the lower than in the upper. Next comes the external incisor tooth, then the anterior molar tooth. About the end of the fifth month we find osseous substance in these three teeth, while only the germ exists in the other two. We have as yet been unable to determine whether the canine or the posterior molar tooth is ossified first, because, except in one instance, we have always found these teeth with or without traces of the osseous germ at the same time. Probably, however, ossification commences first in the former, not only because we have once found in it an osseous germ, while there was none in the posterior molar tooth, but because its osseous nucleus has always seemed to us more extensive than that of the latter, and finally because it is cut first. But these three reasons, particularly the last two, do not establish our opinion with certainty.

At the seventh month of pregnancy all the deciduous teeth contain osseous nuclei.*

The number and arrangement of the pieces of bone which form the teeth are not always exactly the same.

Hunter† and Rudolphi‡ think that the incisors are composed of three pieces, a central and two lateral pieces, which are smaller. The canine teeth arise by a single osseous germ according to Hunter; but Rudolphi thinks by two lateral halves. Both admit that the anterior molar tooth is formed of an anterior portion and of one or two posterior pieces, and that the posterior is formed by an anterior germ and several posterior nuclei. Hunter, however, is very brief on this subject, although he seems to speak from observation. Rudolphi's assertions are grounded, not on researches in regard to the development of the teeth in the fœtus, but upon chemical experiments, having for their object the action of the acids on perfect teeth, which action reduces them to the number of pieces mentioned by this physiologist. Numerous observations on the fœtus have convinced us that the canine and the incisor teeth are developed by a single germ, which arises at the centre and gradually extends to the sides. We cannot then consider as natural, conclusions drawn from the action of acids on perfect teeth; and farther, because other writers, as Albinus§ and Blake|| formally assert that the incisor and canine teeth are developed by one nucleus of ossification. But the molar teeth in fact arise by several osseous

* Blake (*Essai*, p. 23) states only that he has found osseous substance in all the teeth in a fœtus of eight months.

† *Loc. cit.*, p. 88.

‡ *Ueber die Zähne*; in his *Anatomisch physiologische Untersuchungen*, p. 126.

§ *De dentium ortu et incremento*; in the *Annot. acad.*, book ii., ch. ii., p. 16.

|| *Loc. cit.*, p. 6.

nuclei, each of which corresponds perfectly to the first rudiment of a single incisor or canine tooth.

First the anterior piece, which is the largest, appears; this corresponds peculiarly to the incisors, and is narrower according to its height than it is afterwards. Next is seen the posterior piece, which is much smaller; it gradually extends and unites to the other directly or on one of the two sides by a third which is developed at a later period. The second molar tooth arises by several pieces, at least three and generally four in number, an anterior, two lateral, and a posterior. The anterior piece is always larger than the others.

All the pieces except the small one, which belongs to the posterior molar tooth, are usually fused at birth.

About this period the development of the first and second incisor tooth is nearly equally advanced in regard to the whole crown. Next comes the anterior molar tooth, the crown of which has not yet however acquired all its height. The third is the canine tooth. The most imperfect is the posterior molar tooth, the very thin crown of which presents in one or more points considerable spaces in its central portion, and a piece which is entirely distinct from the others. The posterior molar teeth of the lower jaw not unfrequently form a single piece in the full grown fœtus. Beside the spaces and the separation mentioned disappear in the two jaws in the first few months after birth.

The cutting of the deciduous teeth usually commences at the beginning of the seventh month after birth. The lower internal incisors are generally first seen; some weeks after, the upper internal incisors are cut; one or two months afterward, the upper and lower external incisors; at the end of the first year, the lower anterior molar teeth; some time afterward, the upper anterior molar teeth; at the age of eighteen months the inferior, and soon after the superior canine teeth; toward the end of the second year, the posterior molar teeth; so that at the age of three years all the deciduous teeth are seen.

The deciduous teeth receive a distinct artery, which comes from the dental artery, and which passes through a canal in the jaw, into which it enters through a special foramen.*

2. Permanent teeth.

§ 2123. The permanent teeth are developed and appear nearly in the same order as the deciduous teeth. They however pass through their periods much more slowly.

We observe first just before the end of the first month of pregnancy the follicle of the anterior molar tooth. Those of the incisors do not

* Serres, *loc. cit.*, p. 16.

form till the commencement of the eighth month; next that of the canine, and next that of the middle great molar tooth. That of the anterior small molar tooth forms some months after birth, rarely before the seventh or eighth. Next appears that of the posterior small molar tooth, and usually at four years of age that of the third great molar tooth, which is situated the most posteriorly. The osseous germs are visible nearly at the same time as the follicles.

Ossification commences in the anterior great molar tooth. Usually the external anterior point of this tooth presents at the end of the last month of pregnancy, a small osseous piece, to which four or five others are gradually attached separately; these do not unite till the end of the first year. We however have sometimes found in a very large full grown fœtus five points, in fact entirely distinct from each other, the posterior of which was still very small.

All the permanent teeth have not the same situation in respect to the deciduous teeth. The three posterior molar teeth are situated on the same range as these latter, but farther outward, while those which should be properly called the replacing teeth are included between them and the posterior wall of the alveolar processes, the incisors, the canine, and the molar teeth, behind those to which they correspond. The follicles of the permanent teeth are at first contained in the same alveolar processes as the old teeth. The manner in which they are developed is very curious. They leave the upper and posterior part of the dental follicles already existing, so that they may be considered to a certain extent as arising from these latter by gemmation. They first rest directly on them, and even afterwards when they are elongated they communicate with them by long and thin cords.

Our observations, however, have established that this communication is only between the external layers of the dental follicles, that the internal layers are much more essential, and entirely distinct from each other, so that the new internal dental sac is developed in the old, between it and the external layer, although their cavities are unconnected. If they communicate, it must have been at a very remote period, since we have never been able to discover it even on examining the follicles of the permanent teeth when they first appear.

The new sacs are gradually separated from the old by the formation of new alveolar cavities. These cavities seem at first slight depressions in the posterior wall of the old; these depressions, like the follicles, are much shorter than these latter, and extend much farther beyond the alveolar edge than those which existed previously. A septum gradually arises from the base of the alveolar processes, and goes towards its orifice. The two alveolar processes, however, continue to communicate by a considerable opening, through which passes the cord which unites the two sacs. The elongation and the thinness of this cord depend on the increase in the height of the jaws.

The openings between the incisors and the canine teeth are visible on the posterior face of the jaws. That of the internal incisor tooth corresponds to the cavity of the deciduous internal incisor tooth. That

of the external is situated between the cavity of the deciduous external incisor tooth and that of the deciduous canine tooth. That of the canine tooth is situated behind the cavity of the deciduous canine tooth. The communications of the anterior molar teeth with the cavities of the deciduous molar teeth are not visible externally, according to several anatomists,* but exist at the bottom of those latter; we, however, have observed that they are situated like the first, on the inside, and behind the alveolar opening of the deciduous tooth, and that they are generally narrower than the others.† The follicles of the second and third permanent molar teeth emerge in the same manner, the first on the outside of the deciduous molar tooth, the other afterward, on the outside of the second. The foramina of communication between their cavities are situated at the upper part of the septum which separates them. As the jaw and the deciduous teeth gradually arise by the development and completion of their roots, as the permanent teeth which replace the latter do not increase proportionally in this direction, and as they are much broader than the deciduous teeth, it follows that they are situated lower, and also a little on the outside of them. The permanent internal incisor teeth are situated behind the internal and a part of the external deciduous teeth; the permanent external teeth behind these latter and the deciduous canine teeth; finally, the anterior molar teeth behind the deciduous molar teeth and between their roots. The crowns of the latter nearly touch the roots of the permanent internal incisor teeth, and the canine teeth are on the outside of the row, more remote from the alveolar edge, and are carried farther forward than the others.

§ 2124. At the age of six or seven years the second dentition commences; the deciduous teeth fall out and the permanent teeth appear. At this time the artery of the deciduous teeth and its canal disappear more or less perfectly,‡ so that the dental capsules receive no more nutritious fluid. Usually, and in fact almost always, the permanent anterior molar teeth begin to appear before the time of the second dentition, which has deceived some writers, and led them to admit twenty-four deciduous teeth. Among the teeth which alone deserve to be called permanent teeth, the inferior internal incisor teeth usually appear first. Next come the superior internal, then the external; afterward, and usually at the age of from thirteen to fourteen years, and almost always at the same time, the canine and the middle great molar teeth appear; finally, at a variable period, between sixteen and twenty years, and sometimes later, the last great molar teeth appear, which are hence called the *wisdom* teeth (*dentes sapientiæ*). Thus, although the permanent canine teeth appear much sooner than the small molar teeth, they however normally are cut afterward, between the appearance of these latter and the posterior molar teeth,

* Albinus, *loc. cit.*, p. 13-15.—Blake, *loc. cit.*, p. 40.—Serres, *loc. cit.*, p. 38.
† Meckel, *loc. cit.*
‡ Serres, *loc. cit.*, p. 19.

exactly as the deciduous canine teeth appear in the jaws, between the two deciduous molar teeth.

The order then in which the teeth are cut, is nearly the same for the deciduous and the permanent teeth.

Both resemble formations which are permanent in animals.

The appearance of the incisors before the others deserves notice, as it resembles the development of the intermaxillary bone, and the corresponding middle portion of the lower jaw which exist particularly in fishes, and more or less in all animals. The earlier development of the lower represents remarkably the formation of the ruminantia, and the regular existence of the incisors and the molar teeth without the canine teeth in the rodentia.

The deciduous teeth change in certain respects before falling out. Their roots disappear; they become both shorter and thinner, so that their inner part diminishes as they terminate more or less in a point.

The more or less narrow canal in which the cavity of the permanent tooth is first situated, gradually enlarges, as well as its orifice, as the tooth advances; finally, the septum which separates the alveolar process of the permanent tooth from that of the deciduous tooth, is destroyed, and the two teeth are then situated in the same cavity as they were originally, with this difference, however, that the permanent tooth, from its greater size, always penetrates partly into the alveolar process of the adjacent deciduous tooth.

The destruction of the root of the deciduous tooth doubtless depends on the mechanical action of the permanent tooth upon it, in accordance with the law, that long continued pressure on a part, causes it to disappear by obstructing nutrition, or by accelerating the destructive process. This is proved not only by the disappearance of the deciduous tooth, but also by the well known fact that those temporary teeth which are not replaced by the permanent teeth, continue very long even in the adult, and sometimes even during existence.* Although the tooth which continues longer than usual often finally falls out,† we must not conclude that the permanent teeth have no effect in the normal state independent of their influence, but only that the deciduous teeth from their primitive destination, exist so short a time that this action is not absolutely necessary to determine their decay. Finally, the continuance of the deciduous teeth even after their vessels and nerves have completely disappeared, is favoured by the adhesions between their root and the inner face of the alveolar process.‡

The permanent tooth causes the decay of the deciduous tooth principally by pressing upon the vessels and nerves of this latter, and likewise its adhesions with the alveolar process, and destroying them. The destruction of the root is not indispensable, nor even constant, as the deciduous teeth are sometimes shed, preserving their roots entire.§

* Hunter, *loc. cit.*, p. 99.—Hudson, in Blake, p. 67.—Fox, *loc. cit.*, p. 40.
† Fox, *loc. cit.*
‡ Serres, *loc. cit.*, p. 97.
§ Idem, *loc. cit.*, p. 102.

This is the proximate cause of the loss of the tooth, and not, as has been asserted, the space formed by the disappearance of the septum between the alveolar processes, the only effect of which space would be to fix the tooth less firmly.* In fact, there is no space, since the permanent tooth, in proportion as it destroys the septum, prevents the space from forming, as it enters the alveolar process of the deciduous tooth.

§ 2125. From our preceding remarks it follows, that the teeth resemble the bones generally in their chemical composition and hardness.

They, however, differ from them in these two respects:—

1st. They are harder.

2nd. Their tissue is much more solid.

3rd. They are composed of two substances.

4th. They contain a much greater proportion of earthy salts.

They differ also from the bones.

5th. They are unattached in most of their extent.

6th. In their mode of connections with the rest of the body, and in their relations with the germ of the tooth.

7th. In their mode of development.

8th. Because they do not participate in the diseases of the osseous system.

9th. They receive no vessels.

10th. They resist much more the action of chemical agents and spontaneous decomposition after death.

In all these respects, on the contrary, they are very similar to the epidermoid parts, which analogy is confirmed by comparative anatomy.†

* Serres, *loc. cit.*, p. 104.

† Mayer and Kathoven are the first who arranged the teeth as belonging to the horny system, which has been followed by Heusinger, but opposed by Rudolphi, but very wrongly. Bonn (*De contin. membran.*, 1763, § 16), Walther (*Physiologie*, vol. i. p, 176), and Lavagna (*loc. cit.*, p. 164), had already mentioned the analogy between the teeth and the hairs. This point of doctrine had been carefully developed by Lavagna, and afterwards by Heusinger. The reasons alleged by the latter are, 1st. The teeth in the different mammalia present imperceptible transitions, from those which are most similar to the bones, to the different parts of the horny system, particularly the nails, the horns, and the hairs. 2nd. The teeth of several of the mammalia have a lamellar texture like the nails and the horns, and this texture, although very evident in all, sometimes seems effaced from the greater accumulation of the earthy salts. 3rd. The development of the teeth is very similar to that of the nails and horns. 4th. Certain teeth are shed and reproduced, as are also the nails and the horns. 5th The teeth are not nourished, they are formed entirely of one piece, and the substance which forms them is not renewed. These views are in part those of Coiter, Herissant, Cuvier, and Serres. G. F. St. Hilaire has adopted them entirely. The tooth, he says, is produced by transudation ; it is an inorganic body, anatomically speaking, a mass composed of several layers, in which there is nothing to be compared with osseous tissue. But this naturalist has extended these ideas very much by demonstrating that we must refer the beak of birds to the formation of the teeth, a curious fact, and one of the highest importance, which fully justifies the analogy established between this formation and the epidermoid tissue. He advances also another idea, which we shall mention here briefly, although connected with important physiological considerations, it is

B. ABNORMAL STATE.

§ 2126. The teeth not unfrequently vary from the normal state; and most generally present anomalies in their texture. The most frequent alterations of texture are those which relate to the period of development, and the order in which it occurs; next, those which relate to the number of the teeth. Next come the anomalies in situation and direction, and finally those in form, size, and continuity of tissue.

a. Deviations of formation.

§ 2127. 1st. *Anomalies in the development.* These are the slightest. Not unfrequently all the teeth, or some of them only, appear unusually late. This is seen particularly in the last molar teeth, in regard to which we should remark, that their unusually late appearance is only an extension of time between their appearance and that of the other teeth, as between the appearance of these latter compared together. It is less common for all or some of the teeth to appear sooner than usual; sometimes, however, children are born with several teeth. It is curious, although the fact agrees very well with the laws and the other phenomena of vegetative life, that this early development seems evidently to be favoured by the longer continuance of the fœtus in the uterus, since in a proportionally great number of children who had continued in the fœtal state some weeks beyond the common period, teeth existed at birth.

We must mention among the anomalies in the development, the continuance of the deciduous teeth beyond the usual period, which does not necessarily oppose the appearence of the permanent teeth, but causes so much irregularity in their arrangement and situation, that we are led at first view to believe the number of the teeth to be increased. But the deciduous teeth frequently remain, although the permanent teeth do not appear, and this anomaly must even be attributed to the absence of the latter.

Beside these differences in the development which relate to the quantity, there are others dependent on the quality. Thus, sometimes all the lower incisor teeth appear before one of the upper is seen. It is much more rare that the superior incisors appear before the inferior, the external before the internal, the anterior molar teeth before the external incisors, and the posterior before the canine teeth.* The rarest

foreign to this work, viz. that if the teeth afterwards serve for mastication, it is fortunate for those animals who possess and profit by them, but that when the formations of the teeth begin to appear in the fœtus, they are real organs of the fœtus; in this sense they arise, like all the organs of sense to form a termination to the circulatory system of the advanced parts of the head, to limit a certain number of vascular trunks. F. T.

* Blake, p. 25.—Fox, *loc. cit.*, p. 7.—Serres, p. 85.

case is where the canine teeth appear before the anterior molar teeth, although several authors mention this as the normal order, or at least state it to be as frequent as that mentioned above.*

2d. *Anomalies in the number.* These teeth which most frequently appear later than the common period, the posterior molar teeth, are also those which are most commonly deficient. Instances, however, are known of the deficiency of every tooth.† In one subject there were only four permanent teeth in each jaw. In another there was only one incisor in the upper jaw. Sometimes the teeth have been entirely deficient.‡

It is more rare to find an excess than a deficiency of teeth. This anomaly, leaving out of view that which is only apparent, and which we have just mentioned, appears principally under two different forms. Sometimes the supernumerary teeth exist simultaneously with the others, sometimes, however, they appear after them.

In the first case they make part of the same range with the others; sometimes are found out of this range, so that when several exist they form a second series. They are generally situated behind the normal teeth, that is, the same relation exists between them and these latter as between the deciduous and the permanent teeth. This anomaly varies in the same manner as that which depends on the abnormal situation of the teeth in general.

The first degree of the redundancy of the teeth is the development of one or more rounded eminences on the sides of the crown; hence are formed what are termed the *dentes proliferi.*§ This anomaly seems to belong almost exclusively to the molar teeth, and it is curious as it is a greater development of one of their peculiar characters, the existence of several points on their crown.

The anomaly is still greater when other smaller separate teeth exist on a normal tooth, and which are seemingly formed by special germs. In the only case of this anomaly known to us, and which existed on a canine tooth, there were three accessory teeth; these small teeth were much smaller than the normal canine teeth, but were all formed after the same type; they rested on the base of the crown and had the same direction.‖

The supernumerary teeth are observed most frequently in the upper jaw and forward, near the canine teeth and the incisors. This peculiarity is very remarkable, since in several animals the anterior teeth are more numerous in the upper than in the lower jaw. They

* Miel, *Bull. de la soc. méd. d'émul.*, 1817, p. 94.
† Fox mentions several instances of this.
‡ Fox, *loc. cit.*—Sabatier, *Anat.*, vol. i. p. 78.
§ Bartholin, *Hist. anat. rar.*, ch. i., p. 49.—Serres, *loc. cit.*, p. 160.—Linden, *Medic. phys.*, cap. xiii., art. 3.—Oudet, *Bull. de la fac. de méd.*, 1821, no. i., p. 369—G. Saint Hilaire has described and figured one of these teeth (*Syst. dentaire des mammif. et des oiseaux*, p. 77, pl. i., fig. 18).
‖ Lemaire, *Deux observations d'anatomie pathologique sur les dents*; in the *Journ. de méd.*, vol. xxxvi., p. 252.

usually differ from all the normal teeth in form and size, being smaller and conical, sometimes bicuspid. When they occur at the posterior part of the mouth they do not resemble the wisdom teeth. Their number varies. Generally they are few, but sometimes they are many; in one case even the whole number of teeth was seventy-two, viz. eight incisors, four canine and twenty-four molar teeth in each jaw.* Possibly, however, this statement is not perfectly correct, and should be considered only as an instance of the coexistence of the deciduous and permanent teeth. Sometimes also when the number of teeth is unusually large this anomaly is caused by the division of one or more into several.

The second mode in which the number of teeth is increased has been termed the *third dentition*. There is even sometimes a fourth dentition, although the instances mentioned of this are hardly credible. The principal circumstances of this remarkable phenomenon are as follow:—

a. The third dentition is attended with the same symptoms as those of the first and second. The new teeth are smaller than those they replace; they are less permanent and soon decay.

b. The period of their formation is not determined. If we may judge of them from some facts, they are formed before they appear; probably, however, individuals differ in this respect.

c. The third dentition usually occurs at a very advanced period of life.

d. The time between the third and second dentition varies. Generally, however, the third teeth appear shortly after the second decay.

e. In this respect there are differences, some of which depend on the quantity, others on the quality. Usually, however, one or more teeth are replaced more frequently than all. The posterior molar teeth seem to be those which are renewed most frequently, and even if this be not true it is a fact that when they are replaced by others the same phenomena are presented as at the second dentition.

3rd. *Anomalies in situation and direction*. They differ considerably:—

a. *Situation*. In this respect the teeth are rarely abnormal, and if they are situated in the range they change their place, so that this anomaly belongs to the history of the lateral inversion. Thus the canine tooth sometimes exists between the two incisors. In other cases the canine tooth is replaced by the first anterior molar tooth, and exists between it and the second.† Sometimes also the teeth are developed in parts of the jaws where they are not generally found. These abnormal teeth are seen most frequently in the palatine process

* Arnold, *Obs. phys. méd.*, p. 69.

† Miel, *Observation sur un cas très rare de transposition des dents*; in the *Journ. de méd.*, vol. xl., 1817, p. 88.

of the upper maxillary bone, directly or at some distance behind the normal teeth. They are in the lower jaw principally situated in its angle. The narrowness of the jaw causes them to project above the others, and their direction is also less perpendicular.

b. Direction. Not unfrequently the teeth are oblique, which depends particularly on the narrowness of the jaw; but here their faces look to the sides, and their edges are turned backward and forward. They are rarely on the contrary reversed, that is, the summits of their roots look to the alveolar edge and the crowns to the opposite region of the jaw.

4th. *Anomalies in the form.* The form of the teeth is abnormal in a great many different modes.

a. In regard to the *whole tooth,* this abnormal formation is indicated by the adhesion of two adjacent teeth; this sometimes extends their whole distance, and is sometimes confined to a portion of their extent, generally to the roots.*

b. Crown. The form of the triturating surface of the crown sometimes varies very much from the common form.

The first great molar tooth seems particularly to have a peculiar tendency to the imperfect development of this surface; for we have sometimes found it on each side in both jaws with a great number of small eminences, a curious analogy with the molar teeth of the hog.

The rest of the crown, instead of being smooth as usual, sometimes presents rounded, transverse, and longitudinal elevations and depressions, which depend on a deficiency in the secretion of the enamel.†

The crown more rarely presents so irregular a form that it appears to be compressed from above downward and reversed.‡

c. Roots. The roots are abnormal more frequently than the crowns. Their principal anomalies are an excess in number and a variation in direction.

Sometimes, although very rarely, the superior molar teeth have five roots,§ and the inferior four.|| More frequently these latter have three. In some subjects we find two in the canine teeth and more rarely in the incisors.¶

In the abnormal direction of the roots of the teeth they are curved very much in the form of a hook**, or they are oblique. These two anomalies are most frequent, particularly in the great molar teeth, which they render more solid.

* Fox, *loc. cit.*, tab. viii., fig. 8-11.
† Idem, *loc. cit.*, tab. viii. fig. 14.
‡ Idem, *loc. cit.*, tab. viii., fig. 11, 12.
§ Idem, *loc. cit.*, fig. 13.
|| Idem, *loc. cit.*, fig. 11.
¶ Tesmer, *Obs. osteol.*, vol. i, fig. 1-4.
** Lemaire, *loc. cit.*, p. 254.

5th. *Anomalies in size.* The upper internal incisors are principally abnormal in this respect from a primitive deviation of formation, being much larger than usual. But the size and mass of the teeth may also be increased or diminished from too great or too slight activity in the formative power.

The roots particularly increase in size, being affected with *hyperostosis**. Sometimes, although more rarely, the crown is unusually large. We must also mention here the formation of a bony substance in the cavity of the tooth, which sometimes adheres to the parietes and sometimes is developed in the centre of the soft pulp which fills this cavity†.

Atrophia is the opposite of hyperostosis; when it takes place in the crown it sometimes does not extend beyond the enamel, or at least it begins with the layer of enamel, although it extends gradually to the osseous substance. This latter is unaltered in its texture, and the cavity of the tooth is not exposed. The anterior teeth are more subject to this disease, which attacks only their anterior face and is seen particularly in scrofulous subjects.

6th. *Solutions of continuity.* The fractures of the teeth rarely supervene unless preceded by an alteration of texture, which renders these parts brittle. In this case, whether the scale be detached or there is simply a fissure, the solution of continuity does not close, while it is perfectly healed even when there is a loss of substance, when the tooth is perfectly healthy. The latter applies equally to transverse and longitudinal fractures.

The fractures of the roots, however, alone are consolidated. Those of the crowns do not heal, which undoubtedly depends on the fact that union takes place by an exudation of osseous substance on the outer face of the germ of the tooth, in accordance with the law of the normal formation of the tooth. It appears then from this, that the external membrane, termed the periosteum of the tooth, takes no more part in the cicatrization than in the primitive formation of the tooth.‡

b. Alterations of texture.

§ 2128. The *alterations in the texture of the teeth* are:—

1st. *Caries.* It is the most common. It usually proceeds from without inward, more rarely from within outward, begins by the destruction of the enamel, and seldom extends beyond the crown. It attacks the molar teeth most frequently. It is rarely or never observed at an advanced age.

* Fox, *loc. cit.*, tab. i.

† Duval, *Cons. méd. sur les dents*; in the *Journ. de méd.*, vol. xxxvi.; *Bull. de la fac. de méd.*, p. 101.

‡ Duval, *Sur la consolidation des fractures des dents*; in the *Journ. de méd.*, vol. xiii., p. 275.

Sometimes the germ inflames, suppurates, and dies, independent of the solid substance of the tooth.* Its inflammation seems to precede the caries of the tooth.†

2nd. The teeth rarely participate in the general *softening* of the bones.

3rd. The formation in the alveolar processes of cysts filled with a liquid, sometimes serous and sometimes thicker than serum. These cysts partially destroy the root of the tooth.

The gum frequently softens, and then bleeds at the least touch.

The abnormal swelling of this tissue with softening constitutes *epulis*, which term embraces, however, very different alterations of texture.

II. CERVICAL AND THORACIC PORTIONS OF THE ALIMENTARY CANAL.

§ 2129. The cervical and thoracic portion of the alimentary canal ‡ are much more simple than the cephalic. They include the *pharynx* and the *esophagus*. The first begins at the posterior extremity of the cavities of the mouth and nose, and is uninterruptedly continuous with the esophagus, which is connected with the stomach.

A. PERFECT STATE.

I. PHARYNX.

§ 2130. The *pharynx* § extends in a straight line from the base of the skull and the fauces to the lower extremity of the larynx, or to the fifth cervical vertebra. Its mean measure is four inches long and one in diameter at its broadest part when moderately distended. Below this point it contracts, then dilates again, becomes narrower, and is finally continuous with the esophagus.

Its posterior straight face is situated directly before the five superior cervical vertebræ and the anterior muscles of the neck, behind the cavity of the mouth and the larynx, between the great vascular and nervous trunks of the neck.

Its upper extremity or arch (*fornix*) is united by some cellular tissue to the lower face of the body of the basilar bone and the petrous portion of the temporal bone. Some muscles to be described

* Duval, *loc. cit.*, vol. xxxvi., p. 99, 100.

† Serres, *loc. cit.*, p. 51.

‡ Fabricius of Aquapendente, *De gulâ et ventriculo*, Padua, 1618.—J. Fantoni, *De gulâ et ventriculo*, Turin, 1742.

§ Santorini, *De pharynge*; in the *Obs. anat.*, cap. vii.

hereafter attach it to different parts of the head. Upward and backward are the posterior nostrils, forward the orifice of the cavity of the mouth, backward and on the sides those of the Eustachian tubes. These different openings exist at its upper part, which is divided by the soft palate to a certain extent into an anterior and a posterior passage.

§ 2131. It is surrounded externally by a thin layer of cellular tissue, which attaches it loosely to the adjacent parts. Below this layer is another, which is easily separated from it; this is also cellular and is filled with fat, and intimately unites it with the subjacent muscular layer. The nervous and vascular trunks which enter into the proper membranes of the pharynx are distributed in them.

§ 2132. The muscular tunic or pharynx is formed principally by the three *constrictor* muscles (*M. constrictores pharyngis*),* a *superior*, a *middle*, and an *inferior*. These muscles have several common characters, which are:

1st. They surround the pharynx backward and on the sides; their lateral extremities are attached to the adjacent hard parts before the pharynx, especially to several bones of the face and skull, to the hyoid bone and to the larynx.

2nd. They are composed of fibres which proceed from below upward and from without inward, and which extend by radiation from each side to the median line.

3rd. They partially cover each other from below upward.

4th. They are voluntary muscles.

A. CONSTRICTOR PHARYNGIS INFERIOR.

§ 2133. The *constrictor pharyngis inferior* or the *crico-thyreo-pharyngeus* muscle arises by from two to four triangular digitations, from the cricoid and the thyroid cartilages.

The lowest and smallest is attached below the crico-thyroideus muscle to the lower part of the side, and to the lower part of the posterior horn of the cricoid cartilage.

The upper, the larger, is sometimes single and sometimes triple; it arises from all the posterior part of the side of the thyroid cartilage, excepting the lower region occupied by the crico-thyroideus muscle, which is situated between it and the lower digitation.

The fibres of this muscle proceed from all these points, divided into several fasciculi in a greater or less extent, and go toward the median line, so that the inferior are almost transverse, while the others ascend more the higher they become, and unite at angles more and more acute with those of the opposite side on the median line.

* Santorini, *Septemdecim tabulæ*, tab. vi.

The upper head of this muscle is only about an inch below the upper extremity of the pharynx.

B. CONSTRICTOR PHARYNGIS MEDIUS.

§ 2134. The *constrictor pharyngis medius* muscle (*M. constrictor medius pharyngis*, s. *glosso-hyo-pharyngeus*, s. *kerato-chondro-pharyngeus*, s. *cephalo-pharyngeus*) is much smaller and weaker than the preceding. It arises from the hyoid bone and the tongue, generally by two heads. The *inferior* or *posterior*, the smaller, termed the *hyo-pharyngeus* muscle, comes from the posterior part of the upper edge of the great horn of the hyoid bone.

The *upper* or *anterior*, which is the larger and is termed the *glosso-chondro-pharyngeus* muscle, arises from the small horn of the hyoid bone and from the base of the tongue.

Its lower fibres are transverse and even convex downward; the upper are very oblique and are generally pointed, and either alone or blended with the upper fibres of the constrictor pharyngis inferior muscle, extends as the *cephalo-pharyngeus* muscle, to the basilar process of the basilar bone, and is attached to its lower face by fleshy or tendinous extremities.

C. CONSTRICTOR PHARYNGIS SUPERIOR.

§ 2135. The *constrictor phryngis superior* or the *glosso-mylo-pterygo-pharyngeus* muscle arises from the posterior part and the side of the root of the tongue, from the inner face of the lower maxillary bone, near the posterior molar tooth, from the hook of the pterygoid process, and from the tendon of the peristaphylinus externus muscle, often also a little from the petrous portion of the temporal bone and from the styloid process, and blends with the posterior part of the genio-glossus and buccinator muscles, and often also with the lower portion of the stylo-pharyngeus muscle.

Its lower fibres are transverse; the upper describe an arch which is convex upward.

D. STYLO-PHARYNGEUS.

§ 2136. The *stylo-pharyngeus* muscle (*M. stylo-pharyngeus*, s. *levator*, s. *dilator pharyngis*) is large, elongated, and rounded. It arises by a broad and short tendon from the inner face and the lower edge of the styloid process of the temporal bone. Thence it goes inward and downward. It is at first separated from the constrictor pharyngis superior muscle by a greater or less quantity of fat; it goes from above downward and from without inward, passes

under the lateral part of the constrictor medius muscle, and is distributed on the lateral and posterior wall of the constrictor medius, and adheres to its vascular tunic very intimately by a dense cellular tissue.

Its upper fibres curve in an arch from below upward and interlace with those of the superior constrictor. The inferior separate like a pair of forceps. Both decend to the base of the upper horn of the thyroid cartilage, and are attached to its posterior edge,

This muscle raises the pharynx and the larynx, and dilates the first of these two cavities transversely.

§ 2137. The vascular tunic of the pharynx which is considerably thick comes next to the muscular portion.

The inner tunic or the mucous membrane is very thin, smooth, and reddish white. It is uninterruptedly continuous above with that of the mouth and nose, below with that of the esophagus.

II. ESOPHAGUS.

§ 2138. The *esophagus* * is that part of the alimentary canal included between the pharynx and the stomach. It is narrower than either, and is continuous with them at its two extremities by tunnel-like portions,

This canal is situated in the posterior mediastinum, and extends its whole length before the vertebral column. Its upper part corresponds directly to the anterior face of the spine from the fifth cervical vertebra and the cricoid cartilage, where it commences, to the fifth dorsal vertebra, although it frequently also inclines a little to the left. From this point to the ninth dorsal vertebra it inclines slightly to the right; it then returns on the anterior face of the column, passes through the esophageal fissure of the diaphragm, and soon terminates at the upper or left orifice of the stomach.

At its upper part it is situated behind the trachea. From the fifth dorsal vertebra it is found between the aorta on the left and the azygos vein on the right side. It is united to the adjacent parts by a very loose cellular tissue.

§ 2139. The esophagus is the narrowest part of the aliamentary canal. Even in its greatest dilatation its diameter is not an inch. It it is equally broad in every part, except at most the slightly contracted portion which passes through the diaphragm.

The muscular tunic is considerably thick; it is generally at least a line in thickness.

It is composed of two layers, one external longitudinal, the other internal transverse, the first of which is twice as thick as the second. The] longitudinal fibres usually commence above by three fasciculi

* J. Bleuland, *Observationes anatomico-medicæ de sana et morbosa œsophagi structura*, Leyden, 1785.—V. Malacarne, *Sull' esofago, sulle intestine, e sopra alcune valvule del tubo alimentare*, Padua, 1803.

or heads, a middle and two lateral. The middle head arises by a tendon from the centre of the posterior face of the cricoid cartilage directly below its upper edge, and expands a little in descending. The two lateral heads, which are fleshy, descend from the lower edge of the constrictor pharyngis inferior muscle. These three fasciculi unite some inches below the upper extremity to form a muscular membrane which is uniformly extended.

The circular fibres are a continuation of the inner posterior part of the constrictor pharyngis inferior muscle, but are much thinner than those of this muscle.

The upper are transverse; the next are oblique from above downward and from without inward, intercross with those of the opposite side, and describe spiral lines; the inferior, like the superior, form straight rings. This canal for about an inch at the upper end of the esophagus presents no circular fibres on its anterior face, and as the longitudinal fasciculi are not united in this place, the esophagus is here much less muscular and more extensible than in other parts.

The cellular or vascular tunic comes next to the muscular, and is attached to it very loosely, while it adheres strongly to the internal membrane with which it forms an internal canal which is easily detached from the muscular membrane.

In this tunic there are numerous muciparous glands arranged very compactly and composed of smaller granulations, which diminish in number and size as they approach the lower extremity.

The inner or villous tunic is whitish, solid, and presents, on its inner face, numerous and very narrow longitudinal grooves separated by parietes. We ought not to consider it as the same with the preceding.*

Its inner face is covered with a thinner, more delicate, and moist membrane, which is evidently an epidermis, and which suddenly terminates at the lower part of the esophagus at the part where it is continuous with the stomach. The folds of this epidermis are easily separated by boiling and maceration, although it is difficult to detach it entire unless it is morbidly thicker and firmer from some pathological change. Farther, the lower extremity of the esophagus is detached from above downward in one or more parts some time after death, which undoubtedly arises from the fact that the fluid secreted by the glands of the esophagus and cardiac portion of the stomachs often and dissolve it, and also the loose cellular tissue which unites it to the cellular tunic.

* Sœmmerring (*Eingeweidelehre*, p. 216) describes these two tunics as forming but one, termed the *vascular* or *internal glandular tunic*; he says that the inner membrane and the vascular membrane of the stomach are continuous with it. It is true that the internal membrane of the stomach is continuous with that of the esophagus, and its vascular membrane with that of this canal. Other anatomists err still more in considering the villous tunic of the stomach and intestinal canal as a continuation of the epidermis of the esophagus.

§ 2140. After the food is masticated by the teeth in the cavity of the mouth, mixed with the saliva and formed into a soft mass, the muscles of the tongue, the hyoid bone, the pharynx, and the esophagus propel it successively toward the stomach; this constitutes *deglutition* (*deglutitio*).* In order to this, the mass of food is moved from before backward in the cavity of the mouth, which motion requires the close of this cavity by approximating the jaws and lips. At the same time, the tongue is moved by its muscles, so that its edges are raised and its centre is depressed, and it thus forms a kind of groove, which touching the palate makes a canal, in which the food proceeds from before backward, because there is the least resistance in this direction. When it has passed through this course, the genio-glossi and genio-hyoidei muscles, which restore the tongue to its position and carry it forward, also favour its progess, because they thus raise the soft palate, to which motion also the lavator muscles of this latter contribute. When the food has arrived at this place the constrictor muscles of the pharynx contract; at the same time the depressors of the soft palate and the stylo-glossi muscles act to raise the tongue and contract the isthmus of the fauces; the contractions of the constrictor pharyngis superior muscle press the pharynx against the soft palate, and thus close the nasal fossæ as they had been before by raising the soft palate. The stylo-pharyngei muscles, then the constrictors of the isthmus of the fauces, raise and dilate the pharynx, so that the food can enter there more easily.

The genio-hyoidei, the mylo hyoidei, the thyro-hyoidei, and the hyo-glossi muscles carry the larynx forward and upward; this motion favours the closing of the glottis by the epiglottis, which the pressure of the food also serves to depress, so that nothing can enter the air passages.

All these parts being extremely irritable act very rapidly and easily. Deglutition, which is at first voluntary, becomes involuntary in the esophagus, although this passage receives its nerves from the pneumo-gastric nerves.

B. ABNORMAL STATE.

I. DEVIATIONS OF FORMATION.

§ 2141. 1st. *Primitive deviations.* Sometimes but rarely the pharynx and the esophagus terminate in a cul-de-sac, one at its lower the other at its upper part, from a primitive deviation of formation. In the

* Schulze, *De deglutitionis mechanismo*, Halle, 1739.—F. B. Albinus, *De deglutitione*, Leyden, 1740.—Wentz, *De deglutitionis mechanismo*, Erlangen, 1780.—P. J. Sandifort, *Deglutitionis mechanismus, verticali sectione narium, oris, faucium illustratus*, Leyden, 1805.

first place the cavity of the mouth also is generally at least imperfectly developed, and the lower jaw is wholly or in great part deficient. The same thing occurs when the pharynx opens in the neck by a very narrow orifice.

Another primitive deviation of formation which is more rare, is the division of a part of the esophagus into two passages situated at the side of each other.*

We cannot always determine if the *contractions* of the esophagus, which depend on the abnormal folding of the inner membrane without any morbid change, are primitive deviations of formation, or are produced consecutively by a simple increase of this membrane.

We must however admit that this latter sometimes occurs, since accidents frequently appear only a little while before death.

2nd. *Accidental deviations of formation. Dilatations* of the esophagus are generally accidental. They usually occur after contractions situated below them, and in this case they are *general.*

More unfrequently a portion of the circumference of the canal appears dilated in a cul-de-sac.† In one case the pouch was certainly caused by a hernia of the internal membrane through the muscular tunic,‡ while in another this latter also contributed to it.§

Pouches of this kind occur only at the lower extremity of the pharynx or at the commencement of the esophagus, doubtless on account of the sudden contraction of the alimentary canal in this place, and because the esophagus is less muscular there than in other parts.

Ruptures of the esophagus which are sometimes transverse || and sometimes longitudinal,¶ are only a greater degree of the hernia of the inner membrane. They are sometimes caused by abnormal brittleness.

When the *contractions* are permanent, they generally supervene after a morbid alteration of texture, as thickening and induration of the coats of the esophagus, so that they are rarely pure deviations of formation. Sometimes, however, they depend originally on a simple abnormal contraction of the muscular fibres, which continues even after death; and the greater hardness in this part does not result from an alteration of texture, but only from a stronger contraction of the muscular tunic, although the continual pressure of the latter on the inner membrane may also change its texture, and

* Blaes, *Obs. medicæ rariores,* tab. vi., fig. 2.
† Meckel, *Handbuch der pathologischen Anatomie,* vol. ii.—Bell, *Surgical observations,* pt. i., London, 1817, p. 167, tab. ii.
‡ Bell, *loc. cit.*
§ Ludlow, *Med. obs. and inq.,* vol. iii.
|| Boerhaave, *His. morbi atrocis,* Leyden, 1724.
¶ Monro, *Morbid anatomy,* p. 311.

excite in it inflammation, followed by effusion and suppuration, which render the induration permanent.*

II. ALTERATIONS OF TEXTURE.

§ 2142. The most common alteration in the texture of the esophagus, is an abnormal hardness, usually attended with thickening, and consequently with a greater or less contraction, or even with a total closing of it,† which state is termed a *scirrhus*, and in which the different tunics of the passage are more or less blended in a mass, sometimes homogeneous and cartilaginous, sometimes divided into several compartments by tendinous septa. Commonly then the texture of the inner face is altered. This alteration is not observed in all parts indiscriminately; it is more frequent at the upper and lower extremities of the esophagus, in the former place, on account of the sudden contraction of the pharynx; in the latter, because the lower portion of the esophagus tends to contract, since the two orifices of the stomach are perfectly closed during digestion, so that it is very easily injured by substances passing through it.

Abnormal communications between the esophagus and the adjacent parts, particularly the trachea,‡ the lungs, § the aorta,‖ may occur from cancer or common ulcerations. This state may also be occasioned by ulcers formed primitively in the aorta.¶

We can sometimes, but not always, determine from the state of the parts which was the primitive disease.

Beside the alterations of texture in the membranes mentioned, *excrescences*, *funguses*, and *polypi* of different kinds, are sometimes, although rarely, developed in the pharynx and the esophagus; these arise from the inner face of this canal,** and usually have their roots in the mucous and vascular membranes. They are sometimes so long, that commencing near the upper extremity of the esophagus, they descend to the stomach. They are sometimes formed by fibres perpendicular to their base,†† are sometimes lobed‡‡ and suppurate.§§

Real ossifications are still more rare.‖‖

* Baillie relates several instances of it: we also have seen it, and like Baillie in the cadavers of females. Mauchart, *De struma æsophagi ejusque coalitu*, Tubingen, 1742.

† Gyser, *De callosa æsophagi angustia*, Strasburg, 1770.—J. Bleuland, *De difficili aut impeditu alimentorum depulsione*, Leyden, 1780.

‡ Van Dœveren, *Obs. anat. pathol.*, Leyden, 1789, obs. ii.

§ Bleuland, *loc. cit.*, obs. i. p. 48. fig. 112.

‖ Van Dœveren, *loc. cit.*, obs. i.

¶ We have one very remarkable case before us.

** Monro, *loc. cit.*, p. 184-189.—Baillie.

†† Baillie, *loc. cit.*

‡‡ Monro, *loc. cit.*, p. 188.

§§ Baillie, *loc. cit.*

‖‖ Meckel, *Handbuch der pathologischen Anatomie*, vol. ii. p. 2. p. 227.

ARTICLE SECOND.

MIDDLE AND INFERIOR PORTION OF THE ALIMENTARY CANAL.

§ 2143. The middle region of the digestive system comprehends the *stomach* and the *small intestine*, and the most important glandular organs of this system, the *liver*, the *spleen*, and the *pancreas*. This is the largest and the most important portion, because digestion takes place in it, for which the preceding portion only prepares, while the terminating portion serves for the expulsion of the residue.

The stomach, the liver, the spleen, and the pancreas, with the commencement of the small intestine, the *duodenum*, into which the pancreas, the liver, and the stomach open, occupy the upper part of the abdominal cavity. They are separated from the lower, which is larger, by a large transverse fold of the peritoneum, the transverse meso-colon. It is not, however, necessary to describe the lower portion of the intestine after these glands, nor to separate the large intestine from the small, since they are both situated in the same cavity, their texture is essentially the same, and they are uninterruptedly continuous with each other.

It is customary to describe the *peritoneum* before mentioning the parts of the digestive system it envelops; but as these are not the only parts covered by it, the prolongations which extend from its outer sac to the organs covered by it, cannot be clearly described until the situation and form of these organs are well known: finally, the important anomalies of this membrane, especially those which occur in hernias, being dependent on those, to which several of the parts it envelops are subject, it is better to defer the description of the peritoneum until we mention the different systems it supports. This is the method followed by Roux in the *Anatomie descriptive* of Bichat.

We shall not deseribe on this occasion the cavity of the abdomen, the most general characters of which have been already mentioned.

A. PERFECT STATE.

§ 2144. The different regions of the middle, portion of the alimentary canal, doubtless differ very much in respect to their capacity; but they are very analogous in regard to texture, in which, however, they differ on the contrary from the upper and lower portions. The longitudinal fibres of the muscular tunic completely surround this portion of the canal; the vessels which go to it are more numerous, and anastomose together more frequently, and finally, the inner surface of the membrane is more or less uneven, from prominences which do not exist in the other two portions.

I. STOMACH.

§ 2145. The *stomach* (*ventriculus, stomachus*),* the broadest part of the alimentary canal, is included between the esophagus and the duodenum. The portion of this canal in the cavity of the abdomen commences with it. The alimentary substances all fall directly within it, assimilation there commences, and they are there changed into a liquid of a peculiar character called *chyme* (*chymus*).

A. SITUATION.

§ 2146. The stomach is situated at the upper part of the abdominal cavity, under the left false ribs. Sometimes, when it is much larger, it descends into the umbilical region. Its direction is oblique from above downward and from left to right. Its upper extremity touches the diaphragm; the lower extends to near the lower edge of the left or square lobe of the liver.

§ 2147. The spleen is situated near its left extremity; behind its posterior face is the pancreas, below it the transverse colon, above it the left or square lobe of the liver and the lobe of Spigel, which is embraced by its upper curve.

B. FORM.

§ 2148. The stomach has the form of an elongated cone, a little curved on itself, and is somewhat similar to a bagpipe. Its right extremity is the narrowest, and its left the broadest portion.

We distinguish in it two orifices, two curves, and two culs-de-sac.

The *upper* or *left* orifice, termed also the *cardiac* (*ostium ventriculi sinistrum*, s. *superius*, s. *cardia*), occupies the highest part of the stomach near its left cul-de-sac. It serves as the limit between this viscus and the esophagus, which, however, are continuous with each other and separated by no prominence, so that the lower extremity of the esophagus gradually enlarges.

The *inferior* or *right* orifice, termed also the *pylorus* (*ostium ventriculi dextrum*, s. *inferius*, s. *pylorus*, s. *janitor*),† is the limit between the stomach and the duodenum. Here the transition is not gradual and imperceptible as on the left side, but occurs by a prominence termed the *valve of the pylorus* (*valvula pylori*).

The faces and the curves of the stomach are included between these two orifices.

* Beside the works of Fabricius, of Aquapendente, Glisson, and Fantoni, already cited, consult also J. D. Metzger, *Ventriculus humanus anatomice et physiologice consideratus*, Konigsberg, 1788.

† Leveling, *Pylorus anatomice atque physiologice consideratus*, Strasburg, 1764.

The *posterior* and the *anterior* faces, when the stomach is more or less distended, are uniformly convex, but when the stomach is empty they are straight, flat, and in contact.

The *upper* or *small curve*, the *diaphragmatic edge*, is situated between the right side of the upper, and the left side of the lower orifice; it is concave and much smaller than the lower, which is also called the *great curve*, the *colic edge.*

When the stomach is empty, the two curves appear as more or less distinct edges, which establish a well marked separation between the two faces. But when the viscus is full, they are very rounded, and insensibly continuous with the two faces.

The *base*, *tubercle*, or *great cul-de-sac* of the *stomach*, the *splenic extremity* (*fundus*, s. *saccus cæcus*), is a prolongation in the form of a cul-de-sac which extends from right to left on leaving the left side of the upper orifice, and which proceeds about three inches beyond the insertion of the esophagus.

This portion of the stomach is not much narrower than its centre. On leaving it and the cardiac orifice, the viscus slightly enlarges to a little beyond its centre from left to right. From this latter point to the pylorus, it gradually contracts very much.

When one or two inches from the pylorus, the great curve suddenly inclines inward, but immediately resumes its former direction, although it does not afterward describe so great a curve as in the rest of its course. Hence, there is a fissure, opposite which the right portion of the small curve, instead of preserving the concave form which it possessed from the cardiac orifice, becomes convex outward, although in this place there is no contraction, between which and the pylorus is a dilatation.

The portion of the stomach farthest from the right side, is termed the *antrum of the pylorus*, or the *small cul-de-sac* (*antrum pylori*).

C. DIMENSIONS.

2149. The size of the stomach varies much in the same individuals, in the state of health at different periods; as this viscus dilates considerably when filled with food, and contracts when empty. Its capacity is diminished particularly in the transverse direction, and often to such an extent that the stomach is smaller than the large intestine is when in its usual and moderate state of distention.

Generally, when the stomach is not unusually full, it is one foot long from the base to the pylorus, three or four inches high in its highest part, and about as many broad from before backward. Its surface is about one square foot in extent.

D. ATTACHMENTS.

§ 2150. The stomach is attached on each side at its upper orifice by a short fold of peritoneum, termed the *phreno-gastric* ligament

(*L. phrenico-gastricum*), which extends on the left to the commencement of the base, and descends on the right along most of the small curve. This ligament is attached forward and upward to the superior lumbar portion of the diaphragm.

To this ligament is attached another which is much longer, the *gastro-splenic* ligament (*L. gastro-splenicum*), which extends from the base of the stomach to the fissure of the spleen, where it is attached, and which is continuous below with the great epiploon.

The stomach is united to the transverse colon by the great epiploon, and to the liver by the small epiploon, internal prolongations of the peritoneum, which we shall describe after giving the history of this membrane.

E. MEMBRANES.

§ 2151. The stomach is enveloped by the peritoneum in every part, excepting a narrow ring which exists along the great and small curve, and along which the blood-vessels proceed.

Below this peritoneal coat, directly on its inner face, is the muscular membrane,* which is very strong, but stronger than in the great and the small intestine, although weaker than in the pharynx and rectum. It is about half a line thick, and its texture is more complex than in the rest of the alimentary canal, and we may, at least in some parts, demonstrate three layers.

The external layer is formed of longitudinal fibres, which mostly blend with those of the esophagus and duodenum, and are uninteruptedly continuous with them. These fibres are very much developed at the upper part of the stomach, around its small curve; they however cover all its surface.

The middle layer is formed by annular fibres, representing rings, the centre of which correspond to the longitudinal axis of the stomach. They commence at the base of the stomach, and interlace with each other, proceed a little obliquely, and cover the whole stomach to the pylorus, where they are strongest.

They are termed transverse or oblique fibres. They form the thickest layer.

Below this layer there is a third,† which is very evident on the left side, and on the small curve, and which also surrounds the stomach circularly, but in an opposite direction from the preceding, that is, longitudinally. They are the continuation of the circular fibres of the esophagus, and frequently interlace with the oblique fibres.

The vascular membrane of the stomach is thicker, more vascular, and more distinct from the internal membrane than in the esophagus.

* D. G. Galeati, *De cornea ventriculi et intestinorum tunica*; in *Comm. Bonon.* 1745.—Bertin, *Description des plans musculeux dont la tunique charnue de l'estomac humain est composée*, vol. ii, p. 235.

† Galeati (*loc. cit.*, p. 240) described this membrane long before Bertin.

It is uninterruptedly continuous with the vascular tunic of this canal, but not with the inner or villous membrane.

The villous membrane of the stomach is thin, soft, loose, and spongy, softer and looser, but a little thicker than the corresponding membrane of the esophagus. It usually assumes, soon after death, a yellowish, brownish, or reddish tint.* Not unfrequently, especially when examined shortly after death, it presents in a greater or less extent, especially at the base and at the small curve, a very red colour, caused by a network of small vessels almost exclusively veins. We generally consider this state as the consequence of an inflammation which had affected the organ during life; and conclude from its existence that the patient had been poisoned. But attentive examination demonstrates that it supervenes during the struggles of death, without any suspicions of such a cause, and is occasioned particularly by the sudden suspension of the circulation in the lungs.†

When the stomach is not distended, its villous membrane, and consequently its inner face, present numerous large and small wrinkles, which are arranged very irregularly. But these wrinkles disappear when this viscus is even very moderately distended, so that when we look at the membrane with the naked eye its inner face seems smooth, although when examined with a microscope this same face seems divided by several small intermediate parieties; which enlarge toward the pylorus, and by this are divided, still more similar to the villosities of the intestines, into numerous compartments; these are arranged very compactly, like the cell sin a bee-hive.‡ The cellules are larger but fewer in the left half of the stomach, and are separated by simple septa. In the region of the pylorus, these septa present numerous grooves which render them still more similar to the villosities of the intestines, although they are much smaller in other respects than these latter.§

Beside numerous slight depressions, which are the orifices of small simple glands, the inner membrane of the stomach also presents,

* The French physicians having studied for several years the alterations in the mucous membrane of the digestive canal, they have naturally considered also its normal conditions. Rousseau, (*Des différens aspects que présente, dans l'état sain, la membrane muqueuse gastro-intestinale*; in the *Archiv. génér. de méd.*, vol. vi., p. 321) has observed, that in the healthy state *it is white or slightly rosy white.* This primitive colour varies in different parts of the alimentary canal. Thus, the mucous membrane of the pharynx is slightly rosy; that of the esophagus is white, particularly at its lower part; in the stomach it has a slight rosy tint as in the pharynx. This rosy colour becomes less intense in its pyloric portion, changes to white in the duodenum, preserves this appearance in the rest of the small intestine, then becomes of a pale white in the cæcum, the colon, the commencement of the rectum, and resumes its slightly reddish colour near the end of this last intestine. F. T.

† J. Yelloly, *On the vascular appearance of the human stomach, which is frequently mistaken for inflammation of that organ*; in the *Med. chir. trans.*, vol. iv. 1813, p. 371—424.

‡ Hewson, *Experim. inq.*, vol. ii., p. 173.

§ E. Home has figured this (*Observations on the gastric glands of the human stomach and the contraction which takes place in that viscus*; in the *Phil. trans.*, 1817, pt. i., p. 347, pl, i, xviii, xix.

especially near the two orifices, others which are larger and which lead to more or less apparent large glands. These last glands form at the union of the esophagus and stomach a very marked prominence from three to four lines broad, which separates the two cavities to a certain extent.

The villous membrane of the stomach is uninterruptedly continuous with that of the esophagus and intestinal canal. But it does not seem to be connected with the epidermis of the esophagus, since we may without the least violence separate this epidermis from it and from the villous tunic of the esophagus around the cardiac orifice.

The membranes of the stomach vary in thickness in different individuals, and in different parts of the viscus of the same individual and at different periods.*

Generally, in the first respect, they are thickest in those male subjects who enjoy good health, and in the second they are thicker, as is easily imagined, the less the stomach is distended. In regard to the third we may admit that the peritoneal coat is equally thick in every part, while the others are much thinner in this cul-de-sac of the stomach than in the other parts of the viscus, and are thickest near the pylorus, where they are frequently six times thicker than at the base.

F. VALVE OF THE PYLORUS.

§ 2152. The *valve of the pylorus* (*valvula pylori*) is formed by the circular fibres of the muscular tunic, and also by the vascular and mucous tunics of the stomach and duodenum. The first two membranes are much thicker in this place, and all three are reflected on themselves from without inward.

The longitudinal fibres in the peritoneal coat only pass on this point to the outside.

It is very easy to remove the valve by cutting or raising the longitudinal fibres. But there is always a contraction at the union of the stomach with the duodenum.

A peculiar glandular substance has been mentioned as situated between the muscular and peritoneal tunics, and as forming the pylorus and determining its form;† but with the utmost care in our dissections we have never been able to discover the least trace of this substance, although we always find a very thick glandular layer before the pylorus, below the muscular membrane of the duodenum.

The form of the valve varies.

It generally circumscribes the whole orifice of the viscus, and it is sometimes circular and sometimes more or less oval; in the latter case its longitudinal diameter usually extends from above downward.

* Yelloly, *loc. cit.*, p. 400, 402.
† Sœmmerring, *Eingeweidelehre*, p. 236.—Portal, *An. méd.*, vol. v., p. 161.

It is more unfrequently semicircular, surrounding only a part of the orifice.

Between this formation and the preceding there is an intermediate degree in which the valve differs considerably in its breadth, according to the different parts in which it is examined.

It is sometimes larger and sometimes smaller.

It is not certain that we ought always to admit that it possesses during life the form which it has after death.

We cannot determine precisely what effect a given form of the valve has even, admitting its existence and permanence during life, on the action of the valve and on the more or less closing of the pylorus by it, since it is evident that the degree of contractility in the circular fibres which contribute principally to form this fold has still more influence.

G. TRANSIENT MODIFICATIONS IN THE FORM AND SITUATION OF THE STOMACH.

§ 2153. The stomach presents regularly transient modifications in its situation, according as it does or does not contain food. These modifications correspond then to the different states of digestion.

The stomach is not only smaller when perfectly empty than when it contains food, but then its form is not cylindrical. Its anterior and posterior faces touch and its two edges are distinct from each other, while when full, it edges and faces are imperceptibly continuous.

A still more remarkable modification occurring during digestion, is, that the stomach is then divided into a right and a left half; this occurs about its centre, and is more or less distinct. The left half contains the fluids and the right the solid substances, and the former pass out from them into the small intestine without proceeding necessarily or at least entirely through the right half and the pylorus.*

The orifices of the stomach are more or less perfectly closed during digestion; when, however, this process has continued some time the pylorus opens, and the mass contained in the stomach passes through it to descend into the duodenum, in proportion as it is digested.

The situation of the stomach also changes during digestion; it turns on its axis, so that its anterior face looks more upward and the posterior downward, although this apparent change in situation depends principally on that in its form above mentioned.

H. FUNCTION OF THE STOMACH.

§ 2154. The inner membrane of the stomach secretes the *gastric juice* (*succus gastricus*), a fluid the exact nature of which it is difficult to determine, as it is always more or less mixed with the substances

* E. Home, *Lectures on comparative anatomy*, vol. i., p. 138.

introduced into this viscus. It generally contains an uncombined acid.*

It however appears to be sometimes acid and sometimes neutral in the same subject. Its base seems to be an albuminous substance very analogous to that in the saliva.† Perhaps its composition is not always the same, and varies from the nature of the substances which act on the inner membrane of the stomach. The action of this fluid, united perhaps with that of the bile, changes the food into a mucilaginous, grey, and thick pulp, of a disagreeable odour and taste, termed *chyme* (*chymus*). The nature of this pulp varies with that of the alimentary substances; it includes more solid parts and less of salts than any other of the animal fluids. It contains much carbon and albumen, but no gelatine, at least if we may judge from some experiments. It forms gradually in the pyloric portion.

The formation of chyme, or the *digestion in the stomach*, is singularly favoured by the closing of its two orifices. We must also mention among the causes which favour this process the motions of the stomach, which are at first vague and irregular, but which gradually take place about the end of chymification from the cardiac to the pyloric orifice.

I. SEXUAL DIFFERENCES.

§ 2155. The stomach is the only portion of he alimentary canal which presents sexual differences. It is larger, shorter, and broader in the male ; smaller, narrower, and longer in the female. Its muscular coat, like that in the whole alimentary canal, is generally also thinner in the female. (*a*)

II. SMALL INTESTINE.

§ 2156. The *small intestine* (*intestinum tenue*,)§ the narrowest and thinnest portion of the intestinal canal, is included between the sto-

* This opinion has at least become very general since the time of Spallanzani, although the experiments of Montègre tend to prove that it is not always correct. Prout asserts that the free or at least the unsaturated acid often existing in the stomach of animals is the hydrochloric, and that the salts commonly found in this viscus are the alkaline hydrochlorates (*Phil. trans.*, 1824, p. 1). Children has arrived at the same result by analyzing the fluids vomited by a man during a violent attack of dyspepsia (*Annals of philosophy*, 1824, July). F. T.

† Bostock, in the *Med. chir. trans.* vol. iv., p. 177.

‡ Marcet, in the *Med. chir. trans.*, vol. vi., p. 627.—Prout, *Mémoire sur l'hematose et le sang en général*; in the *Journ. compl. des sc. méd.*, vol. xi. p. 132—215.

(*a*) Beside the sexual differences, Dr. S. Th. de Sœmmerring has shown that the stomach of the negro differs from that of the European, in being of a more rounded form, approaching that of the ape.

§ Helvetius, *Observations sur la membrane interne des intestins grêles, appelée veloutée, sur leur membrane nerveuse, et sur leur membrane musculeuse ou charnue*; in the *Mém. de Paris*, 1721, p. 392-405.—C. R. Albinus, *Descriptio intestinorum tenuium hominis*, Leyden, 1722, 1724.

mach and the large intestine. It is uninterruptedly continuous with both, although separated by two valvular folds, the pylorus and the ilieo-cæcal valve, the closing of which can perfectly insulate its cavity, which is sometimes the case.

Its outer circumference is uniform; this is also the case with its diameter in most of its extent, and hence it is cylindrical.

Its whole length from the pylorus to the commencement of the colon varies much from thirteen to twenty-seven feet, although the length of the body does not differ in the same proportion.

It is about an inch in diameter when moderately distended.

The description of the duodenum may be separated from that of the small intestine, as it differs from this latter in several respects.

A. DUODENUM.

§ 2157. The commencement of the small intestine, that portion directly next to the stomach, is called the *duodenum* from its length.*

This intestine is situated in the right half of the abdomen. It describes a considerable arch, the convexity of which looks to the right and the concavity to the left. We distinguish in it three parts, a *superior*, which ascends obliquely from left to right and a little from before backward; a *middle*, oblique from right to left and descending; finally an *inferior*, oblique from right to left and ascending.

It is attached to the gall-bladder and to the commencement of the transverse colon. Its upper and smallest portion is situated above, and the lower and largest, below the transverse colon. It is covered in most of its anterior face by the posterior wall of the peritoneum, which extends forward in this place to form the transverse mesocolon, surrounds it loosely, and keeps it fixed against the posterior wall of the abdominal cavity.

The middle portion descends below the transverse mesocolon, and when this fold of the peritoneum is raised it is seen on the right side of the mesentery.

The third, on the contrary, is situated on the left side of the mesentery, the upper part of which arises from it directly. It extends to the second lumbar vertebra, goes forward in the place where the upper extremity of the mesentery blends with the transverse mesocolon and opens into the jejunum.

If we except its first portion, which is covered in every part by the peritoneum, the duodenum is protected by this membrane only on its anterior side; the posterior is attached by a very loose cellular tissue to the posterior wall of the abdomen and directly to the organs situated behind it.

* L. Claussen, *De intestini duodeni situ et nexu*, Leipsic, 1757.—Sandifort, *Tabulæ intestini duodeni*, Leyden, 1780.

The middle portion descends along the concave edge of the right kidney and on the right side of the vertebral column to the fourth lumbar vertebra.

The inferior ascending portion is situated on the right side of the vena-cava and the right renal vessels, on the left side of the aorta, behind the upper part of the root of the mesentery, the superior mesenteric artery, and the great mesaraic vein.

Its left and concave portion closely embraces the right half of the pancreas.

§ 2158. The duodenum is generally broader at its origin than in any other part; its concave face is corrugated, its convex face is smooth and tense.

It differs from the other portions of the small intestine by its situation and the firm manner in which it is kept in place, and also by its greater extent and the less regularity of its folds.

B. MEMBRANES OF THE SMALL INTESTINE.

§ 2159. The small intestine is covered externally in all its extent by the peritoneum, and, except the duodenum, it is attached to the lumbar portion of the vertebral column by a long fold of this membrane, termed the *mesentery* (*mesenterium*).

Below this peritoneal tunic is the thin muscular membrane,* which is about a third of a line thick.

The external or longitudinal layer, although much thinner than the internal, with which it is very intimately united and which is never entirely deficient, surrounds the canal almost entirely.

The internal layer is transverse or rather oblique, and circumscribes it entirely.

The vascular membrane presents nothing remarkable.†

The small intestine differs from the other portions of the intestinal canal principally by the arrangement of its inner or mucous membrane.‡ The principal character which distinguishes this membrane is the singular increase of its extent and the greater development of its surface, compared with that of the external membranes, especially the muscular and the peritoneal tunics.

This enlargement depends on its folding from without inward, which gives rise to two kinds of folds, the great and the small folds.

The great folds are termed *valves* (*valvulæ*), and the small, *villosities* (*villi*).

* V. Malacarne, *Sulla structura anatomica delle intestine*; in the *Memorie della societa italiana*, vol. x., p. 27-62.

† B. S. Albinus, *Diss. de arteriis et venis intestinorum hominis*, Leyden, 1736. — J. Bleuland, *Vasculorum in intestinorum tenuium tunicis subtilioris anatomes opera detegendorum descriptio*, Utrecht, 1797.

‡ Helvetius, *loc. cit.* D. G. Galeati, *De cribriformi intestinorum tunica*; in the *Comm. Bonon.*, vol. i., 1731, p. 359-370.

Both are developed principally at the upper extremity of the small intestine. They diminish much in number and size from the origin of this organ to its termination.

C. VALVES.

§ 2160. The valves are three lines high at the upper part of the small intestine.

They have a transverse direction, and most of them occupy the whole circumference of the intestine, so that they form circles which circumscribe it. But they divide once or twice in their course, and also communicate with each other by oblique or perpendicular elevations, which generally are less prominent and much shorter than they; three or four of them always exist between each pair of valves.

They are very numerous, being only a few lines distant from each other.

There are but very few at the lower part of the small intestine, but before entirely disappearing, they gradually diminish in elevation and breadth.

They are formed only by the inner membrane and by the vascular tunic of the intestine, so that they cannot move themselves, but they are floated by the motions caused by the muscular tunic in the fluids within the intestinal canal. When we cut the intestine, we observe that they are directed towards each other, so that if we immerse the organ in water they cover one another like the tiles of a roof.

Hence the term *valvulæ conniventes*, applied to them by Kerckring; but it is wrong to ascribe this discovery to this anatomist, from which error they have derived the name of the *valves of Kerckring* (*valvulæ Kerckringii*).

An artery and vein usually pass through the base of each valve.

These valves delay the course of the substances in the aliamentary canal; hence their greater development at the upper part of the small intestine is curious, since the fluid contained in this portion possesses the most nutritious particles.

They are no less curious as a peculiar character of the human organism. Morgagni mentions their absence in some ruminantia.* We have also looked for them in vain in many mammalia of all orders, even among the apes. In fact several fishes present very analogous transverse valves, which are often very numerous; but they occupy the end of the intestinal canal in these animals, and they have no villosities. They present also this character in those reptiles in which we have seen them.†

* *Ep. an.*, xiv., p. 20.

† *Deutsches Archiv. für die Physiologie*, vol iii., part ii.

We may then say, in order to express the preceding proposition more precisely, that man is the only being possessing both transverse folds and villosities in the small intestine, and alone presents the union of these two organic arrangements, which are found separately in other animals. In fact most mammalia and birds, as also some reptiles and fishes, present only the villosities, and but a few genera of the last two classes the transverse folds.

D. VILLOSITIES.

§ 2161. The *villosities** are small thin prolongations, which are generally rounded, sometimes cylindrical, sometimes conical, and terminated insensibly in a point; finally, sometimes enlarged at their loose extremity; they are attached to the mucous membrane; hence the term *villous tunic* (*tunica villosa*), often applied to it.

The villosities cover all the inner face of the mucous membrane of the small intestine, being very compact at its upper part, while at the lower part they are more or less remote from each other. In regard to their form, some authors, as Galeati, admit that they are cylindrical, or pointed at the origin of the intestine, and conical at its termination, but this difference is not constant. We have always found on the contrary, which agrees with the observations of Hewson, that the villosities at the upper part of the canal are broader in proportion to their length, and that from their form, they resemble the valvulæ conniventes, while as those of the lower part were thinner, elongated, and even sometimes longer than the preceding. They are about one quarter of a line long. As they are arranged very compactly, and as there are about four thousand in a square inch, we may estimate their whole number as more than a million, which is very moderate.

When examined by the microscope, they appear formed of a granular substance, and their surface is not perfectly smooth, although it is not indented. When the blood-vessels of the intestinal canal are injected, the villosities are not only more apparent and filled with injection, but their surface is more uneven, because a vascular net-work is developed in it.

When the lymphatics are injected, we see on their surface a net-work formed by these vessels.

They are then composed of cellular tissue, in which are blood-vessels and lymphatics, the parietes of which are not distinct from its substance. It has long been disputed, whether the villosities open on their surface or not?

* Beside the works of Helvetius, Galeati, and A. Meckel, consult particularly on the villosities:—J. N. Lieberkuhn, *De fabricâ et actione villorum intestinorum tenuium hominis*, Leyden, 1745.—Hewson, in his *Exp. inq.*, vol. ii. c. xii.—R. A. Hedwig, *Disquisitio ampullarum Lieberkuhnii physica-microscopica*, Leipsic, 1797.—C. A. Rudolphi, in his *Abhandlungen*, &c. p. 39.

Excellent observers, as Lieberkuhn, Hunter, Cruikshank, Hewson, Hedwig, and Bleuland, admit these openings, and assert they have seen them. Lieberkuhn and Bleuland think there is generally only one at the extremity of each villosity, rarely several. Others mention more, and assert they are situated in the same place. When a minute injection has raised, inflated, and rendered the villosities cylindrical, they appear spongy, and perforated at their extremity, while they remain smooth and united on the sides. We cannot consider these openings as arising from accidental ruptures, since they are empty and entirely separated from each other, and they also occur only in determinate points, while in ruptures of a part, the vessels of which are filled with injection, we should necessarily see this injection. Cruikshank and Hunter have counted twenty of these openings in the villosities, which were not injected, but only gorged with chyle.

The arguments of Rudolphi who has never seen these openings, do not refute the assertions of the observers above mentioned. He does not mention Hewson at all. The diameter of the openings figured by Cruikshank and Bleuland, which seems too great to be correct, may depend on some individual peculiarity, on the state in which the activity was at the moment of death, or even on some disease, all which circumstances would render the openings more perceptible. If Hewson has not figured them in all the villosities, it may depend either on their diameter, or on the situation of the villosities, and the manner in which they were lighted.

Thus, although these openings are not necessary to explain the phenomenon of absorption, they seem to exist.*

E. GLANDS.

§ 2162. The inner membrane of the small intestine is covered with numberless muciparous glands, which differ in their size and arrangement.

In its whole length, and on all its surface, there are very numerous distinct glands, which are the smallest (G. *mucosæ*, s. *cryptæ minimæ*), and which cannot be seen without a miscroscope.†

* Strictly speaking, the question is, whether the pores of the villosities, for they must necessarily exist in every organic or inorganic substance, possess a special organization, so that they may be compared to a certain extent with the lachrymal puncta for instance. But it is what it does not seem to be, and we cannot but apply to microscopical observations, where the illusions are so frequent and difficult to avoid, the axiom. that a negative assertion does not refute a positive one, when the latter is supported by good authority. The researches of A. Meckel, the brother of the author, also favour Rudolphi's opinion. This anatomist does not admit vessels in the villosities of the intestine, and thinks that the injection which penetrates into them transudes through the parietes of the arterial terminations, to be distributed in the cellular tissue which forms them. Farther, he has found, contrary to the assertion of all his predecessors, that the villosities are always flattened layers, most generally turned on their axes, and often folded on each side, so as to form a semi-canal or a groove, which arrangements vary infinitely, and by which he explains the different appearances described by authors before him. F. T.

† Galeati, *loc. cit.*—Lieberkuhn, *De villis intestinorum.*

Others are much larger, and divided into two classes, the *solitary* (*G. solitariæ*) and the *agglomerate* (*G. agminatæ*). The first are termed also *the glands of Brunner*,* and the others *the glands of Peyer*.†

The glands of Brunner are seen particularly at the commencement of the small intestine, especially in the duodenum, where they appear in the form of small, flat, rounded, lenticular bodies, at most one line in diameter, situated on the posterior face of the mucous membrane, and which open into the cavity of the intestine by broad orifices.

When these simple glands are very large, and project considerably above the inner face of this portion, or the other parts of the canal, it is always from a morbid state.

The glands of Peyer rarely exist except in the ileon, where they enlarge much from the commencement to the end of the intestine.

They form about thirty masses, which are generally oblong and rounded, seldom triangular or almost square, the longitudinal axis of which is parallel to that of the intestinal canal; they are rarely more broad than long, and they do not exist on the side of the intestine corresponding to the mesentery, but on the lateral portions, particularly the anterior.

They are not prominent, or at least project but little above the surface of the intestine, and they are distinguished only by the intestine being less transparent in the points they occupy. They form on the posterior face of the mucous membrane, a thin layer which is composed of bright, transparent, rounded, and slightly depressed points, and of darker edges in the spaces between these points.

They vary in length from some lines to three or four inches; they are about nine lines broad.

At the upper part of the ileon they are five or six inches distant from each other; but at the lower part, and near its termination, they are almost blended with each other, and sometimes form in the loose portion of the edge of the small intestine, an almost uninterrupted layer eight inches long.

F. FUNCTIONS OF THE SMALL INTESTINE.

§ 2163. The inner membrane of the small intestine secretes the *intestinal mucus* (*mucus intestinalis*) and the *intestinal liquid* (*liquor entericus*), which probably form one and the same fluid, partially favouring the assimilation of the alimentary substances by its action upon them, and also their progress by the lubricating layer on the surface of the intestine. This progress is caused by the muscular tunic, which alternately dilates and contracts from the commencement of the small intestine to its termination, so as to send forward

* Brunner, *Glandulæ intestini duodeni, s. pancreas secundarius*, Frankfort, 1715.

† C. Peyer, *De glandulis intestinorum*, Schafhouse, 1677.

its contents in the same direction. In passing through the small intestine, but particularly in the duodenum, and from the influence of bile, aided by that of the pancreatic juice, the chyme is separated into two portions, the *chyle* (*chylus*), a whitish fluid, similar in its chemical properties to the blood and the *fæcal matter* (*fæces*). The chyle is absorbed by the villosities of the intestine, whence it passes into the lymphatic vessels, and probably also into the meseraic veins. The fæces proceed into the large intestine.

III. LARGE INTESTINE.

§ 2164. The *large intestine* (*intestinum crassum*, s. *colon*) differs from the small intestine in its situation and attachments, form, length, breadth, and the arrangement of its tunics.

A. SITUATION AND ATTACHMENTS.

§ 2165. The large intestine describes an arch, the direction of which is from below upward, then goes transversely from right to left, and finally from above downward, begins at the lower extremity of the small intestine, and terminates at the anus. It commences at the right iliac region, but not always in the same point. This point is generally situated at the upper extremity of the anterior face of the right illacus muscle, between this and the psoas muscle; sometimes, also, it occurs much lower, and sometimes much higher, before the right psoas muscle. The small and the large intestine are intimately attached in this place to the iliacus muscle by a short cellular tissue, and the first is there continuous from within outward, and from below upward with the second.

The higher, that is, the more abnormal the union between the two, the more similar the arrangement to that in the fœtus.

At the point of union the commencement of the colon presents a prominence which extends below its terminating extremity, and is termed the *cœcum* and the *cœcal appendix*.

B. DIVISION OF THE LARGE INTESTINE.

A. ILEO-COLIC VALVE.

§ 2166. The small intestine is suddenly continuous with the large, at the point mentioned, so that it enters there at an acute angle from below upward, from left to right, and from within outward, for about an inch, and there forms a prominence termed the *ileo-colic valve*,* or the *valve* of *Bauhin* (*valvula ileo-colica*, s. *Bauhini*). This valve is

* L. Heister, *De valvula coli*, Altdorf, 1748.—J. N. Lieberkuhn, *De valvula coli*, Leyden, 1739.—Haller, *De valvula coli*, Gottingen, 1742.—J. M. Rœderer, *De valvula coli*, Strasburg, 1768.

composed of two layers, a superior, generally a little narrower and almost horizontal, which forms nearly a right angle with the ascending portion of the colon, and an inferior, which is broader, and describes a more acute angle with this same portion.

Between the two layers is a transverse and oblong opening, which is the slightly contracted orifice of the small intestine.

Each is formed by the inner membrane of the vascular tunic, and the circular fibres of the muscular membrane of the large and the small intestine which are turned over in this place, while the longitudinal fibres and the peritoneal tunic, which do not fold, pass like a bridge from the loose portion of the small intestine on the large. The muscular tunics of the two intestines are united with each other at their external face by mucous tissue, and when we consider only the valve, they form its most internal part or its centre. When we carefully destroy the cellular tissue which unites them, the valve entirely disappears, the small intestine opens directly into the large by a broader orifice than the rest of its calibre, in the form of a trumpet, and then the union of the two intestines still more resembles that of the esophagus with the stomach, since in both places the line of demarkation is evidently indicated by a very evident difference in the texture of the inner membrane, by the greater size of the lower portion into which the other opens, and by its projecting above this latter, giving rise to a cul-de-sac.

§ 2167. In the normal state the ileo-colic valve separates the small from the large intestine, so as to allow the substances contained in the first to pass into the second, but entirely preventing them from re-ascending from the latter into the former. This effect depends both on the action of the muscular fibres and the form of the valve.

B. CŒCUM AND VERMIFORM APPENDIX.

§ 2168. The portion of small intestine which passes beyond the colon, (§ 2166) is composed of the *cœcum* (*intestinum cœcum*), and of the *vermiform appendix* (*appendicula vermiformis*),* which originally form but one, and which do not begin to be distinct until after the early years of life.

§ 2169. The *cœcum* is elongated, triangular, and as large as the rest of the colon. It extends from an inch to an inch and a half beyond the terminating portion of the small intestine. The muscular fibres, in particular, are very irregular, and very much interlaced near its closed extremity. It is terminated by a blunt summit, of which the *vermiform appendix* is the prolongation;† the latter, however, rarely leaves its centre, but arises from its left side a little posteriorly.

* J. N. Lieberkuhn, *De valvula coli et usu processus vermicularis*, Leyden, 1739. J. Vosse, *De intestino cœco ejusque appendice vermiformi*, Gottingen, 1749.—Van den Busch, *De intestino cœco ejusque processu vermiformi*, Gottingen, 1814.

† Louyer Villermay, *Observations pour servir à l'histoire des inflammations de l'appendice du cœcum*; in the *Archiv. génér, de médecine*, vol. v. p. 246.

It is the narrowest part of the alimentary canal. A small fold of peritoneum unites it to the lower extremity of the mesentery, and to the spermatic vessels which are situated below it.

This appendix is generally about three inches long.

Excepting its orifice, which is a little broader than the rest, and tunnel-shaped, its breadth is nearly equal in every part, and is about two lines. It is terminated in a blunt summit. A transverse fold, a kind of valve, sometimes, but not always, separates it from the cœcum.*

Near the end of the cœcum, the three bands which form the longitudinal muscular layer of the large intestine, unite to form a thinner and uniformly expanded membrane, which is extended on the vermiform appendix, where it assumes the same arrangement.

§ 2170. The parietes of this appendix are as thick as those of the large intestine, and its inner membrane forms, from its great number of large and extremely compact muciparous glands, a very complex net-work, similar, although much larger than that formed by the inequalities of the inner face of the rest of the colon.

Not unfrequently, although not always, this inner face also presents larger transverse prominences, folds similar to those at the orifice of the appendix.

The vermiform appendix is not always situated exactly in the same place; it sometimes descends almost entirely into the pelvis, the edge of its mesentery opposite to that which adheres to it, being loose. Sometimes it goes upward, passing under the commencement of the large intestine. Sometimes then it assumes this ascending direction in its whole extent, and sometimes its lower extremity again curves downward in a greater or less extent.

C. ASCENDING COLON.

§ 2171. The large intestine begins with the *right* or *ascending colon* (*I. colon dextrum*, s. *ascendens*), which is its shortest portion, ascends before the right kidney, with which it is intimately united by the *right lumbar meso-colon*, and extends to the anterior part of the lower face of the right lobe of the liver. In this place it describes a right or an acute angle under the base of the gall-bladder, with which it has normally no connection, goes to the right, and is continuous with the transverse colon.

D. TRANSVERSE COLON.

§ 2172. The *transverse colon* (*colon transversum*) is attached to the posterior wall of the abdomen by a much broader fold of the peritoneum than that of the preceding, termed the *transverse meso-colon*; it is situated below the stomach, with which it is always more or less

* Morgagni, *Advers. anat. Anim. XIV.*—Bonazzoli, *Observ. in intesi. et renibus habitæ*; in the *Comm. Bonon.*, vol. ii. p. 2. p. 138.

intimately united by the great epiploon, and always descends more or less before the folds of the small intestine, usually to the umbilical region, sometimes even to the small pelvis. It is always much longer than the ascending colon, and sometimes very much exceeds it in size, and then describes several circumvolutions. It extends from the right to the left side. Its two extremities are intimately attached to the duodenum by the meso-colon, which is much shorter in these two parts than in its centre. On the centre of the anterior face of the right kidney, and at the lower extremity of the spleen, it is continuous with the descending colon, describing either an arch, or a more or less acute and sometimes a double angle.

E. DESCENDING COLON.

§ 2173. The *descending colon* (*I. colon descendens*) extends from the lower extremity of the spleen to the pelvis, passing along the lower half of the anterior face of the left kidney, then the quadratus lumborum muscle, and finally the upper and inner part of the left iliacus muscle. It is continuous with the rectum before the right sacro-iliac symphasis.

It is attached to the posterior wall of the abdomen, above by a short, and below by a very large fold of the peritoneum.

This lower part projects more or less forward, and to the right, and sometimes adheres to the cœcum; it describes a curve, hence it is called the *S*, or *sigmoid flexure of the colon* (*flexura sigmoidea*, s. *iliaca*, s. *S. romanum*).

F. RECTUM.

§ 2174. The *rectum* (*I. rectum*) is the last portion of the intestinal canal, and it opens externally by the anus. It begins at the lower extremity of the colon, is attached to the left half of the anterior face of the sacrum in a slight portion of its upper extremity, by a short fold of the peritoneum, termed the *meso-rectum*, and in the rest, simply by cellular tissue; it goes from left to right, and from above downward, so long as it is surrounded by the peritoneum, and does not begin to descend in a straight line until this membrane leaves it.

Sometimes it descends in the pelvis on the right, and not on the left side of the sacrum. In one case of this kind observed by us, the great inferior left curve or the sigmoid flexure of the colon, advanced very much toward the right, united very intimately at its centre with the commencement of the ascending colon, and was attached in this manner to the right side. Its ascending and descending portions were also attached and separated a little from each other inferiorly. Below this point, the commencement of the curve and that of the rectum were also united by a fold of peritoneum, whence there was a considerable depression, which might easily receive a portion of small intestine several inches long, and thus give rise to an internal hernia.

Although we may justly consider the rectum as the lower part of the large intestine, the rectum differs from it in several respects. In fact:

1st. It is almost always much broader, and in this respect it exceeds more or less the other portions.

2nd. The peritoneum covers it only in its upper region; even there it covers, in most of its extent, only its anterior face, and forms no epiploic appendages on its surface.

3rd. Its muscular fibres are much stronger, and the longitudinal layer surrounds it in every part.

The inner membrane is also smooth and filled with simple muciparous glands, but these glands are smaller and fewer.*

* The recto-vesical operation for stone, introduced by Sanson, which becomes more extensively known every day (J. L. Sanson, *Des moyens de parvenir à la vessie par le rectum*, Paris, 1817), requires a more detailed description of the anatomical relations of the rectum. Taken as a whole, this intestine extends from the upper strait of the pelvis to the anus. Its direction is at first a little oblique from left to right, and it curves toward the lower part of the cavity of the pelvis to go from behind forward, under the bladder, to the level of the prostate gland, below which it again curves from above downward, and a little from before backward. We may then consider it formed by three parts separated by these two curves, and distinct in their situation and structure, and the nature and importance of their connections. The first or superior is directed from above downward, and a little obliquely from left to right; it extends from the end of the sigmoid flexure of the colon to the place where the intestine leaves its peritoneal envelop, and curves to go below the bladder: it forms more than half of the rectum. It is tortuous, loose, smooth, covered by the peritoneum, and attached loosely to the posterior wall of the cavity of the pelvis by a fold of this membrane. The second or central part is included between the two curves, and is about three inches long; its direction is oblique from above downward and from behind forward; it is slightly curved in the same direction, is fixed and immoveable, and constantly corresponds posteriorly to the lower part of the sacrum, the coccyx, and the base formed by the ischio-coccygei muscles: forward to the base of the bladder, from which it is separated downward and outward by the seminal vesicles and the vasa deferentia, and still lower by the prostate gland: finally, on the sides to an abundance of cellular tissue. It differs in structure and organization from the upper portion, being wholly destitute of the peritoneum, except sometimes at the highest part of its anterior face, when the bladder is considerably retracted; its muscular coat also is much thicker, and formed of much stronger and more numerous longitudinal fibres; it is every where surrounded by a cellular tissue, compact only below the prostate gland, loose and very abundant in the rest of the circumference of the intestine. Finally, the lower portion of this latter commences below and on a level with the prostate gland, and terminates at the anus. It varies in length from one inch to an inch and a half. It is broader above than below. Its direction is oblique from above downward, and a little from before backward. Near its origin it is every where surrounded by an abundant cellular tissue, except forward, where it corresponds to the prostate gland; in the rest of its extent it is enveloped by the sphincters. Its structure differs much from that of the other portions. In fact, when the rectum curves a second time below the prostate gland, its fleshy tunic, which is very thick, and composed of numerous longitudinal fibres, terminates suddenly; the mucous membrane alone extends to the skin, surrounded by the round muscular fibres of the sphincters, which meet and form a kind of ring, much thinner at its origin than on the side of the skin, where it becomes much thicker, and gives rise to two caudiform prolongations, of which the anterior, the longer, goes toward the bulb of the urethra, and there blends with the bulbo-cavernosus muscle, while the posterior proceeds to the coccyx. This muscular ring is covered internally by the end of the mucous tunic of the intestine, is united forward and upward to the prostate gland, and is adapted in every part to very abundant and fatty cellular tissue. Thus the upper

C. FORM.

§ 2175. The large intestine is not uniformly cylindrical like the other sections of the intestinal canal, but presents numerous elevations and depressions, which render its surface uneven. In fact the longitudinal fibres are there united in three bands separated by spaces, and the muscular membrane considered generally is shorter than the inner tunics. Hence it follows, that when the cavity of the large intestine receives the residue of digestion, it forms between the three bands three series of rounded bursæ which vary in size, and are termed *cellules* (*cellulæ*, s. *haustra*).

These bursæ are all similar but are not perfectly alike, and are no where arranged symmetrically. Their origin from the cause mentioned is proved by the fact that on cutting the bands the inequalities disappear in the place corresponding to the incision, and the canal there possesses a perfectly cylindrical form.

D. LENGTH AND BREADTH.

§ 2176. The length of the large intestine is about five feet, and its breadth when moderately distended varies between an inch and a half and two inches.

E. ARRANGEMENT OF THE TUNICS.

A. PERITONEAL COAT.

§ 2177. In most of its extent, especially in its ascending and descending portions, the large intestine is covered by the peritoneum only forward and on its sides and not on its posterior face, which is attached to the adjacent parts only by very loose cellular tissue. The transverse portion, on the contrary, is every where surrounded by the peritoneum. From the loose portion of the peritoneal coat arise the *epiploic appendages* (*appendices epiploicæ.*)

B. MUSCULAR MEMBRANE.

§ 2178. The muscular membrane of the large intestine, except the rectum, is thinner even than that of the small intestine. It is composed, as in every other part, of longitudinal and of transverse fibres.

portion of the rectum is moveable, and covered by the peritoneum, while the middle and inferior parts, forming together about at least four inches, are surrounded in every part by an abundance of cellular tissue, and are attached, but have no peritoneal envelop. F. T.

The longitudinal fibres distinguish the large intestine from all the other portions of the intestinal canal in this respect, that generally speaking, they are united in three bands, situated at nearly equal distances from each other, about from four to six lines broad, which gradually increase in thickness from the circumference to the centre. One of these bands is situated posteriorly, and corresponds to the point where the intestine is kept in place by the peritoneum; the second is anterior, and proceeds in the middle portion below the insertion of the epiploon; the third occupies the inside of the ascending and the descending portion, and the lower side of the transverse portion, where it is perfectly loose. All terminate at the vermiform process and in the longitudinal fibres of the rectum.

The thickness of the muscular tunic of the large intestine is diminished by the insulation of its longitudinal fibres.

The bands are much thicker the greater the number of these fibres, from which they arise.

They are about half a line thick, so that the thickness of the muscular tunic is considerable in the parts which correspond to them.

We also find at intervals between these three bands several distinct fasciculi of longitudinal fibres; and in subjects where the muscular system is very much developed, the large intestine is entirely surrounded by a layer of these fibres, always arranged, however, so that the intermediate fibres are much weaker than the three bands.

The circular fibres constantly surround the whole of the intestine, but they are much feebler than the longitudinal.

C. MUCOUS MEMBRANE.

§ 2179. The mucous membrane is perfectly smooth when considered superficially, but when examined attentively we observe that it is uneven, from numerous small, rounded, oblong, compact depressions, similar to the points of pins. These depressions give it a shaggy or honey-comb appearance, as is seen on the inner face of the mucous membrane of the stomach.* The elevations between them occupy a greater space than they, and may be considered as corresponding to the villosities of the small intestine.

The arrangement of the inner membrane of the two sections of the intestinal canal differs extremely at the place where they unite, and these two sections are separated by a very distinct line of demarkation, although uninterruptedly continuous with each other.

We cannot determine whether the function of these depressions is to secrete, any more than the other parts. We know, however, that they are not surrounded by a substance different from that of the rest of the mucous membrane; but this latter appears more thin and more transparent in these points than in the intervals between them.

* This has already been observed by Hewson (*Exp. inq.*, pt. ii., p. 174).

The mucous membrane of the large intestine presents a great number of muciparous glands, which are distinct or united in pairs or in triplets, and situated near each other. These glands represent small depressions with a more or less elevated edge. They are very evident in intestines hardened by alcohol, because then the inner membrane is contracted, and assumes a brownish colour. They are formed partly by the union of several of the smallest glands.*

F. MUSCLES OF THE ANUS.

§ 2180. The lower extremity of the rectum is subject to the influence of the will, and is moved by several muscles, the *sphincters*, the *levatores ani*, and the *transversi perinei* muscles. We shall describe here only the sphincters, referring the history of the others to the chapter on the genital organs, with which they are more intimately connected than with the anus.

§ 2181. The anus has two *sphincters*, an *internal* and an *external*, both of which result from a greater development of the circular fibres of the rectum.

A. SPHINCTER ANI INTERNUS.

§ 2182. The *sphincter ani internus* muscle proves very evidently the origin above mentioned; for the longitudinal fibres of the rectum are deficient from three to four lines, the circular fibres become redder and thicker, have the form of a flattened ring, which extends beyond the longitudinal fibres. This ring is three or four lines high and about two lines thick, and it is situated directly under the skin.

B. SPHINCTER ANI EXTERNUS.

§ 2183. The *sphincter ani externus* muscle is much stronger than the preceding, and although a distinct muscle, exactly surrounds it. It is situated under the skin, to which it adheres very intimately. It is thin and flat; its internal fibres are less arched than the external, and the anterior and the posterior unite at an acute angle. Its anterior and posterior extremities are pointed.

The posterior extremity is attached to the posterior face of the last piece of the coccyx either directly or by a compact cellular tissue.

The anterior blends with the transversus perinei muscle, and usually also in man with the posterior extremity of the bulbo-cavernosus, in the female with the constrictor vaginæ muscle. But sometimes also it terminates in the perineum, either by fleshy or by tendinous fibres, and does not extend to either of these two muscles.

* Galeati, *loc. cit.*, fig. 3.

In the male it is more oblong, and its greatest diameter extends from before backward; in the female it is more circular, and at its anterior part it is broader and stronger. These differences undoubtedly depend on those which exist in the two sexes in the form of the pelvis and the external organs of generation.

G. FUNCTIONS OF THE LARGE INTESTINE.

§ 2184. The large intestine absorbs the small quantity of nutritious substance still contained in its contents, and sends the rest toward the anus. In this course the fæces gradually become harder and more solid. The action of the muscular membrane finally expels them, overcoming the resistance of the spincters with or without the concurrence of the will. This expulsion always occurs periodically.

B. DIFFERENCES DEPENDING ON DEVELOPMENT.

§ 2185. Of all the parts in the abdominal cavity the intestinal canal is formed first; its mode of development and the changes in its situation, form, and volume, present equally remarkable phenomena.*

A. MODE OF DEVELOPMENT.

§ 2186. In respect to the mode of development one part is most intimately connected with the formation of the whole fœtus, but particularly with that of the intestinal canal, and must consequently be mentioned first: we mean the *umbilical vesicle* (*vesicula intestinalis, s. umbilicalis*). It is a small, more or less rounded pouch, situated between the chorion and the amnion, and is probably much larger in proportion to the fœtus the more recent the period of conception. It is even greater than the fœtus during the early periods of gestation, and we have reason to think that it is always formed before it. It extends first to the anterior face of the body of the fœtus, which rests directly upon it. But gradually and even early in the first month of gestation, it diminishes much, and is situated farther from the

* C. F. Wolff, *De formatione intestinorum*; in N. C. Petrop. vol. xii., p. 1768. —Oken, *Anatomisch-physiologische Untersuchungen, angestellt an Schweinsfötus, Schweinsembryonen und Hundsembryonen zur Lösung des Problems über das Nabelbläschen, &c.*, in Oken and Kieser, *Beytragen*, Hamburgh, 1806, 1807.—J. F. Meckel, *Abhandlungen aus der menschlichen und vergleichenden Anatomie*, Halle, 1806.—Id., *Beytragen zur vergleichenden Anatomie*, Halle, 1808, vol i., pt. i., no. 5.—Id., *Ueber die Divertikel*, in Reil, *Archiv. für die Physiologie*, vol. ix.—D. Kieser, *Der Ursprung des Darmkanas aus dem Nabelbläschen*, Gottingen, 1810.—Hoechstetter and Emmert, *Ueber das Nabelbläschen*; in Reil, *Archiv. fur die Physiologie*, vol. x.—Fleischmann, *Leichenöffnungen*, Erlangen, 1815, p. 1-75. —J. F. Meckel, *Sur la formation du canal intestinal dans les mammiferes et en particulier dans l'homme*; in the *Journ. compl. du dict. des sc. méd.*, vol. ii., p. 119 and 289.—L. Rolando, *Sur la formation du canal alimentaire et des viscères qui en dépendent*; in the *Journ. compl. des sc. méd.*, vol. xvi., p. 53.

fœtus, so that in the second month it is on the outside of the umbilical cord.

Do the parietes of the umbilical vesicle and the intestinal canal primitively communicate? Several anatomists of great merit * think that this communication is demonstrated neither in the fœtuses of the mammalia generally nor in that of man in particular. The following facts, however, render this opinion very probable:

1st. The analogy with birds, reptiles, and cartilaginous fishes, to the vitelline membrane of which the umbilical vesicle corresponds perfectly,† and in which it is proved that the communication in dispute exists at all periods of fœtal existence.

2nd. We sometimes perceive in very young fœtuses a canal which goes across the umbilical sheath, from the vesicle to the abdomen, and by which we can at pleasure empty the vesicle of this fluid, and fill it again.‡

3rd. We always find in the fœtus, until the commencement of the fourth month, blood vessels which go from the mesentery to the umbilical vesicle, unite first on this latter, but gradually extend only to the anterior wall of the abdomen, and finally die, and are ruptured or entirely effaced. These are the *omphalo-mesenteric* vsssels (*vasa omphalo-mesaraica*), comprehending an artery and a vein, which arise from the mesenteric vessels.§

These vessels also exist in birds, where they go to the yolk, proceeding along the vitelline canal.

4th. The intestines are at first very near the umbilical vesicle, and are situated out of the abdomen in the umbilical sheath, which at this period really makes part of the abdominal cavity.||

It is not unfrequent, proportionally speaking, to find in the full grown fœtus a canal which extends from the intestine to the umbilicus, which opens in this latter place, and is always attended by the omphalo-mesenteric vessels.¶

It is then very probable, though not certain, from all these facts, that the umbilical vesicle and the intestinal canal originally communicate. There are, however, others which really demonstrate the existence of this communication.

Thus we have mentioned above a human fœtus five lines long, in which we saw distinctly a filament attached to the umbilical vesicle

* Emmert.—Hoeschstetter.—Cuvier, *Ann. du Muséum*, vol. iii.

† Needham, *De form. fœtu*, London, 1667, p. 79.—Blumenbach, *Spec. phys. comp. inter anim. cal. sang. ov. et viv.*, Gottingen, 1789, p. 11.—Sœmmerring, in Haller, *Grundriss der Physiologie*, vol. ii., p. 799, 800.

‡ Hunter, *Anatomische Beschreibung des schwang. Uterus*, p. 68.

§ Meckel, *Handbuch der pathologischen Anatomie*, vol. i., p. 563.—We have since verified this remark in at least ten fœtuses of this age.

|| Meckel, *Abhandlungen*, 1806. p. 301.—Oken, *Beytrage*, 1806. ch. ix.

¶ We have collected, in the first volume of our *Hand. der Path. Anatomie*, all the known cases of this anomaly, one of which we observed and described (Reil, *Archiv. für die Physiologie*, vol. ix).

and extended to the intestine, and we have figured this communication as it exists in fœtuses of sheep and cows,* since admitted by Bojanus also in the fœtuses of sheep.†

Men, however, of high authority, doubt it. Emmert, Hœchstetter, and Cuvier, assert that there is no continuity of substance between the two organs, and that the communication existing between them is established only by the omphalo-mesenteric vessels. In fact, they admit, beside these vessels, a third filament, extended between the vesicle and the intestine, but they do not consider it as a canal of union, but only as a simple prolongation of the peritoneum. The following are the arguments in support of their opinions:

1st. The impossibility of passing water or any other fluid from the vesicle into the intestinal canal.‡

2nd. The great difference between the white and thick substance of the alimentary canal, and the thin reddish membrane of the vesicle, and also the pellucid and delicate membrane which unites these two organs, and accompanies the omphalo-mesenteric vessels.§

But we may reply to the first objection, that the phenomenon on which it rests depends perhaps on the narrowness of the canal, and also on the thinness of the vesicle, and demonstrates at most the absence of a *hollow* canal of communication, the admission of which is not absolutely necessary, since the intestinal canal of several animals is solid at intervals, in the normal state.

The second objection also loses its weight, when we consider that the allantoid membrane and the urachus vary at least as much from the bladder, and we observe as great, or even greater constant differences between different parts of the same system. This remark is more reasonable, since we have found the opening of the communication greatest in sharks, where the differences between the vitelline membrane and the intestinal canal were most distinct. Farther, the differences are also considerable in the cases last mentioned.

We think then that we must at present admit a continuity of substance between the umbilical vesicle and the intestinal canal, without pretending to decide if the cavities of the two organs open into each other.

From the analogy of the development of the intestinal canal in the fœtuses of birds, this canal is formed in the following manner. The vitelline membrane, which is at first in direct contact with the vertebral column, begins by forming a small prominence on each side, so that, originally, the intestine, which has the form of a groove,

* Müller, *De genitalium evolutione*, Halle, 1815, fig. 1-2, p. 11.

† *Sur la vésicule ombilicale du fœtus de brebis*; in the *Journ. compl. du dict. des sc. méd.*, vol. ii., p. 84.—Dutrochet, *Recherches sur les enveloppes du fœtus*; in the *Mém. de la soc. méd. d'émulation de Paris*, 1816; and a note to the *Réflexions du professeur Emmert sur la vésicule ombilicale*, in the *Journ. compl. des sc. méd.*, vol. ii., p. 369.

‡ Emmert, in Reil, *Archiv. für die Physiologie*, vol. x. p. 52.

§ Emmert, *loc. cit.*, p. 75.

opens anteriorly. This groove gradually forms, by the increase of its parietes, from behind forward, from above downward, and from below upward, to the place where the cavity of the intestine communicates with the vitelline sac by the vitelline canal, the diameter of which always diminishes.* Oken's opinion, that the intestinal canal should be considered as a kind of excrescence of the umbilical vesicle, which enters already formed into the abdomen from above and from below, is less probable, and is unsupported by facts.

§ 2187. Does the intestinal canal always communicate with the umbilical vesicle in one determinate point? What is this point?

First, this canal is continuous with the vesicle by its anterior edge, but very probably the point to which the communication is finally confined, always corresponds to a determinate place, although it may vary in a certain extent.

Two such points have been mentioned. Oken thinks it is the point of union between the large and small intestine. He considers the vermiform appendix and the cœcum as the result and the remains of this communication.† In this view of the subject, the umbilical vesicle in collapsing, and the intestinal canal on descending deeply into the abdomen, produce a contraction, a kind of neck, the parietes of which approach, and are finally blended. This separates the intestine from the umbilical vesicle. The canal then enters into the abdominal cavity, where the situation of the intestines, hitherto parallel, necessarily changes, so that the anterior joins the neck at an angle, and the neck becomes a prolongation of the posterior, which preserves its former direction. Hence, according to Oken, the upper intestine seems to penetrate into the lower, the angle of union becomes the ileo-cœcal valve, and the neck gives rise to the cœcum and its vermiform appendix. But,

1st. We do not see why the contraction of the intestine, and their entrance into the abdomen, necessarily result in causing the upper part of the intestine to enter into the lower, and form a vermiform appendix. This is still less probable, inasmuch as the cœcum and the ileo-colic valve are rarely deficient in man from a primitive deviation of formation, while they are normally absent in many mammalia provided with an umbilical vesicle; while others, in whom the cœcum is very large, have no vesicle. The great differences in the length and structure of the cœcum, render Oken's opinion very improbable. It is even more probable, on the contrary, that the consequence of such a formation would be a simple uninterrupted canal.

* Wolff demonstrated long since the manner in which the intestinal canal was formed by the vitelline membrane, in birds, after very correct and careful observations, made at an useful time, that is, at a period very near its first formation. As Needham, Blumenbach, and Sœmmerring, have demonstrated the identity of the vitelline envelop and the umbilical vesicle, Oken had no right to claim, as he has done (*Beytragen zur vergleichenden Anatomie*, 1806.—*Lehrbuch der Naturgeschichte*, 1815, p. 3), the honour of having discovered in the envelops of the fœtus of the hog, that the intestinal canal is formed from the umbilical vesicle.

† *Loc. cit.*, part ii, p. 85.

2nd. The cause to which Oken attributes this change does not exist; for the cœcum is formed long before the intestines pass into the abdomen, and is itself inclosed in the umbilical sheath.

3rd. If the cœcum was the point where the intestine was detached from the umbilical vesicle, it would also be the most anterior part of the intestinal canal, and the nearest to the vesicle. But this never occurs, for we always find a fold of the small intestine before the vermiform appendix. Oken, it is true, has figured the contrary, according to his idea, that in man the intestines must detach themselves from the umbilical vesicle,* but unfortunately this does not exist in nature.

§ 2188. Oken's opinion is still less admissible, since arguments unite to render it very probable, that the communication between the intestine and the umbilical vesicle always exists in a determinate, but very different place from that mentioned by him. This place is in the small intestine, and nearer its lower than its upper extremity.

The arguments in support of this second opinion, all of which are opposed to the theory of Oken, are the following:—

1st. The canals between the intestine and the anterior wall of the abdomen, always proceed from this point.

2nd. In one rare case, in a full grown fœtus, monstrous from the development being arrested at several times, there was a real umbilical vesicle inserted in this canal.†

3rd. In this part of the canal, the vitelline canal in birds and reptiles terminates.

4th. We find as the normal formation in most birds, and perhaps also in some mammalia, and not unfrequently as an anomaly, in this part, and never in any other, in man and other mammalia, a single rounded prolongation, varying in length and breadth, and surrounded by the same membranes. This prolongation, termed the *diverticulum*, is evidently a trace of the primitive canal of communication; it is frequently attended both in the fœtus and adult, with the remains of the omphalo-mesenteric vessels.

Very probably, there is a period in the existence of the human fœtus, when a similar small tubercle exists regularly, after the umbilical vesicle is separated from the intestine. Having found a very large diverticulum attended by the omphalo-mesenteric vessels in four human fœtuses three months old, which we had occasion to examine at nearly the same time, we have reason to think that the appendix continues regularly until this period, that is, long after the intestinal canal has entered the abdomen.‡ But we now renounce this opinion, although it has been refuted by no one. If a diverticulum really exist for some time as a normal formation, it disappears long before the end of the third month of gestation, since we have seen the cœcum in the seventh week, although there was no trace of a diverticulum; whence it follows, that the omphalo-mesenteric vessels

* *Loc. cit.*, p. 84. vol. iv. fig. 14.
† Tiedemann, *Anatomie der kopflosen Missgeburten*, tab. iv.
‡ *Handbuch der pathologischen Anatomie*, vol. i. p. 565.

continue much longer than it. But this circumstance does not prove that the diverticulum never exists normally, or that Oken's opinion of the cœcum is correct.

5th. This is the point whence the omphalo-mesenteric vessels depart to go into the umbilical sheath, after, and even before the intestines have entered the abdomen.

6th. In all these cases one or two normal cœcums always exist in the part where the large intestine unites with the small.

These different arguments seem to us to render the insertion of the umbilical vessels on the ileon much more probable than that of this organ, in the point mentioned by Oken. The diverticulum sometimes found, depends either on an abnormal want of energy in the formative power, or on the fact, that the neck of the umbilical vesicle, which perhaps commonly dies on the surface of the intestine, does not then disappear except in a greater or less extent.

Although these arguments were published long since, Oken still continues to maintain that the cœcum is the part where the intestinal canal is detached from the umbilical vesicle,* and he lays it down as a principle either to oppose us, or to support his opinion: 1st, that there is never but one cœcum; 2nd, that the cœcums of birds do not deserve this name, and are only appendages of the bladder; 3rd, that the cœcum exists in all mammalia, and in all birds and fishes who lay large eggs, while it is so small as to be invisible in a very few of these animals, the eggs of which are small;† 4th, that this organ is the old vitelline canal. As these assertions are published in an elementary work, they deserve to be examined, although it is easily seen that they are totally unfounded.

In establishing his four laws, Oken has forgotten, 1st, of those mammalia which possess two cœcums, as the dama and the phascolomys; 2nd, the co-existence of the canal of the umbilical vesicle, the diverticulum, and the cœcum, in the mammalia and birds; 3rd, the perfect resemblance in the mammalia and birds, in the relations between the cœcums, the vitelline canal, the diverticulum, and the rest of the intestinal canal, since the cœcums always exist on the limit between the large and the small intestine, while this is never true of the canal and the diverticulum; 4th, the absolute want of facts, establishing that the intestinal canal unites with the vesicle by the cœcum, while there are a great number proving that it always occurs near the lower part of the small intestine; 5th, the fact that the volume has no effect on the deficiency of the large or small size, and the other conditions of the cœcum, since it is very large in most mammalia, and is entirely deficient in many birds. Even when we admit that the diverticulum of birds is the cœcum, which, however, is impossible, his third law would still be refuted. His third remark, "that the

* *Zoologie*, 1815, vol. i. p. 2.
† *Loc. cit.*, p. 10.

cœcum exists in all mammalia, &c., but it is so small, as to be invisible in a very few of these animals," is difficult to understand.

Oken has also brought forward in favour of his hypothesis:

1st. The arrangement of the cœcums in fishes, in which the vitelline sac of the superior animals is divided into several culs-de-sac.

2nd. The formation of the chondropterygia,* in which the cœcum arises distinctly from the vitelline sac.

One cannot suppose that he himself believes these two arguments to be valid: for

1st. Comparative anatomy demonstrates most positively, that the cœcums of fishes are pancreatic glands, and no one has hitherto attempted to compare them to the vitelline membrane, which also exists in these animals.

2nd. The cœcum of the chondropterygia is found at the end of the large intestine, and the vitelline canal at the end of the small intestine.

3rd. The vitelline canal is broadly open in the fœtus, and exists at the same time as the cœcum, and is entirely separate from it. This latter continues during life, while the canal entirely disappears.

We then have cause to retain our opinion, as it is also supported by respectable authorities, as Tiedemann,† Cuvier,‡ Dutrochet,§ and Jæger.‖

B. SITUATION.

§ 2189. The situation of the intestinal canal varies at different periods, as one may conclude from the details already mentioned. Although it forms on the anterior face of the vertebral column, it is, however, generally further from it in most of its extent, during the early periods of existence than subsequently. At first only a small portion of its upper and lower extremities exist in the proper abdominal cavity; all the rest is inclosed in the umbilical sheath, which, for this or for other reasons, is then extremely large, and should be considered as a prolongation of the abdomen. At first the upper and lower extremities of the intestinal canal extend in a straight line, side by side, and describe an angle to communicate together; but gradually, at the seventh week of gestation, they proceed backward, begin to become tortuous, and reunite in a fold before the umbilical opening. Only the small intestine is tortuous, the large intestine is perfectly straight, and its blunt extremity, the cœcum, goes forward, but always far behind the anterior extremity of the small intestine.

About the middle of the third month, the intestinal canal enters entirely into the cavity of the abdomen, where the lower part of the

* *Isis*, 1818, p. 20.
† *Anatomie der kopflosen Missgeburten*, p. 66.
‡ *Isis*, 1818, p. 138.
§ *Loc. cit.*
‖ *Deutsches Archiv. für die Physiologie*, vol. iii. p. 543.

small intestine is the last to proceed. At this period, and sometime after, the canal, especially the large intestine, varies as much as before from the arrangement it will afterwards normally possess. In fact, the large intestine is not formed of three portions, two lateral, which are perpendicular, and a middle transverse portion, the right of which is attached to the organs behind it only by a short fold of the peritoneum; but it is formed at first by a perpendicular portion, attached by a long mesentery to the centre of the posterior wall of the abdomen. This portion is gradually reflected from right to left at its summit; it then descends on the right, so that the union of the great and small intestine does not correspond to the right lumbar region until toward the end of the fourth month. For a long time, and until birth, the descending colon describes in the left iliac region, a greater curve than it does in the adult, which undoubtedly depends on the narrowness of the pelvis.

The situation of the stomach differs primitively from that assumed by it in the adult, as it is at first almost perpendicular. The duodenum is detached from it, and goes directly downward and forward without any curve. When the liver diminishes in size, and the intestines enter the abdomen, the stomach and the duodenum gradually change their situation, and assume that which they afterward retain.

C. DIMENSIONS.

§ 2190. The intestinal canal is much shorter and narrower the younger the fœtus is. At first it is no longer than the vertebral column, on the anterior face of which it is developed. It then becomes more extensive, and extends always in a straight line into the umbilical sheath, but when it becomes longer, it is tortuous, being situated in a narrow space.

The small is much broader in proportion to the large intestine the younger the fœtus is. In this respect, the relation between them is opposite to that which exists in the adult, for the small intestine, for a long time, is much greater than the large, and even in the full grown fœtus the latter is frequently not at all or but little broader than it.

On the other hand, the large intestine is much longer in proportion to the small the younger the fœtus is. The difference undoubtedly depends on the fact, that the small intestine is much shorter in proportion to the body in the early periods than in the adult.

The cœcum and the vermiform process are at first very small, but soon increase considerably, so that they are proportionally much larger and broader than they are subsequently. They are not originally separated in the same manner as in the adult; the cœcum is not enlarged before it is continuous with its appendix; the latter is not as narrow, but represents the extremity of the large intestine, which is extended in a cul-de-sac above the ileon, gradually contracting a little on itself.

As the cœcum first appears in man, the mammalia, and birds, as a small tubercle, which gradually enlarges, and of which there is not the least trace at first, this circumstance alone demonstrates that it is not formed in the manner mentioned by Oken, but by an enlargement of the large intestine. Before it appears, there is no mark of difference between the large and the small intestine. The ileo-colic valve is at first imperfect and very small; it however begins to appear at the third month of gestation, and it is perfectly developed in the full grown fœtus.

D. FORM.

§ 2191. The intestinal canal, during its development, differs considerably in its form, and in the arrangement of its membranes.

We have already mentioned the differences which occur in the cœcum, when speaking of those in dimension. We must add the following remarks:

1st. The stomach is at first much longer and more rounded than when the development is completed. The great cul-de-sac does not exist originally, and it afterwards is larger than in the adult.

2nd. The outer face of the large intestine is perfectly smooth until toward the end of the fifth month. The enlargements, which are the sources of its great size, appear first in the transverse colon.

Of the intestinal tunics, the internal particularly presents differences relative to the development of the organ.

1st. It is more uniform in the different regions of the intestinal canal during the early periods of life than subsequently. Of this we may be easily convinced by examining the valvules or the villosities.

a. The villosities do not appear before the third month of gestation. At this time they are seen first along the whole intestinal canal, in the form of longitudinal folds, the surface of which is indented, and which, like the indentations, gradually increase in number. Such is the origin of the villosities. When they are developed in this manner, they exist also in the large intestine till the seventh month of gestation, although their length is less at three months than in the small intestine, and it diminishes, as well as their number, from month to month, in which respect, the two regions of the intestinal canal are at first perfectly similar.

b. The valvules of the jejunum do not exist until the seventh month; they are even in the full grown fœtus but slightly prominent, and easily effaced by compression.

These two peculiarities are curious, as they are analogous to what occurs in animals.

2nd. The inner membrane of the stomach is thicker, and more easily separated from the others in the early periods of fœtal existence than subsequently; it is less easy to insulate it entirely in the form of a perfect sac.

ARTICLE THIRD.

INTESTINAL CANAL IN THE ABNORMAL STATE.

§ 2192. The abdominal portion of the alimentary canal presents numerous anomalies in its form and texture.*

I. DEVIATIONS OF FORMATION.

A. PRIMITIVE DEVIATIONS OF FORMATION.

§ 2193. The primitive deviations of formation belong principally to the class of those which affect the quantity.

Among those of the first class, which essentially consist in an imperfect development of the formative power, or a continuance in the peculiar type of the fœtus, may be arranged the following, some of which certainly belong to this class, and others may probably be arranged in it.

I. GENERAL DEVIATIONS.

1st. *Absence.* This deviation of formation relates principally:

a. To the *stomach*, aspecially in acephalia vera, where the intestinal canal generally terminates in a cul-de-sac at its upper part, and is seldom enlarged. Sometimes a portion of the stomach also is deficient, particularly the pyloric valve, which is wholly or partially absent.†

b. To the *small intestine.* It is deficient wholly or partially, in acephalia vera, in which we often observe that the large intestine, or only the lower part of the small intestine exists.

c. To the *vermiform appendix*, which is sometimes, though rarely, deficient, even when the rest of the canal is not abnormal.

d. To the *ileo-colic valve*, which is then simply replaced by some strong muscular fibres.

e. To the *large intestine.* Here the anomaly exists in several degrees, which are commonly attended with an *imperforate anus*,

* A. Monro, *The morbid anatomy of the human gullet, stomach, and intestines*, Edinburgh, 1811.—A. D. Stone, *A practical treatise on the diseases of the stomach, and of digestion*, London, 1816.—T. A. Hare, *View of the structure, functions, and disorders of the stomach and alimentary organs of the human body*, London, 1821.—G. Law, *Observations on derangements of the digestive organs, and some views of their connection with local complaints*, Edinburgh, 1821.—Scoutetten, *De l'anatomie pathologique en général et de celle du canal digestif en particulier*, Paris, 1822.—Andral, *Recherches sur l'anatomie pathologique du canal digestif*, Paris, 1823.

† Fleischmann, *Leichenöffungen*, p. 100-102.

(*atresia ani*), because it usually attends this last deviation of formation.

Very rarely the large intestine is entirely deficient, existing only as a small appendix in the form of a cul-de-sac of the small intestine. Next in respect to frequency, come those cases in which a small portion of the large intestine is deficient, so that the communication between the large and small intestine is uninterrupted; finally, that where the large intestine is developed to the entrance of the pelvis, but where there is no rectum. Sometimes the rectum partially exists, but it terminates in a cul-de-sac, and the space between it and the lower extremity of the colon is also closed in a cul-de-sac.

In this case the rectum sometimes opens into the vagina (*atresia vaginalis*), the bladder (*a. vesicalis*),* or the urethra (*a. urethralis*), so that a real cloaca is at the same time formed.

2nd. *Diminution in diameter.* This anomaly exists in several degrees; in the greatest degree it constitutes *imperforation* (*a. vera*). It is always attended with the absence of a part, since on account of this defect, the part existing terminates in a cul-de-sac.

It occurs principally in the anus, where it varies much in degree. Sometimes the opening of the rectum is closed only by a thin membrane, sometimes this intestine is replaced entirely by cellular tissue, or by a full and solid cord.

Next comes the large intestine, which is imperforate at a greater or less distance above the anus. The ileon and colon more rarely terminate in a cul-de-sac.

Still more rarely, the same exists in the small intestine, either in some part of its course, or at its upper extremity, or occurs in the stomach, preventing a communication with the small intestine, or finally exists in several points of the intestinal canal.

Strictures,† (*a. spuria*) are most frequent in the rectum and anus. They seem, however, not to be rare in the stomach, where they present remarkable peculiarities. In this case the stomach is most generally divided by a contraction near its centre, into two sacs, a right, narrower and more elongated—a left, larger and more rounded. The upper part of the left sac is usually not concave, but very convex, and the form of the two curves, particularly the inferior, are very much enlarged, the second presenting a deep groove. The esophagus is always inserted at the usual place, and the cul-de-sac is never enlarged. The degree of contraction varies much, from half an inch to five inches, judging from the five cases now before us; but the right half of the viscus preserves its normal direction. However, in one case we saw it turned on its axis, so that the convexity looked up-

* Cavenne, *Observation d'une imperforation de l'anus, avec ouverture de l'intestin dans la vessie*; in the *Archiv. génér. de méd.* vol. v. p. 63.—J. G. Hasselmann, *De ani intestinorumque atresia*, Utrecht, 1819.

† Boyer, *Remarques et observations sur quelques maladies de l'anus*, in *Journ. compl. des. sc. méd.*, vol. ii. p. 24.—G. White, *Observations on strictures of the rectum*, Bath, 1820.

ward and forward, and the concavity downward and backward, and descended here before the right end of the cardiac half.

More rarely the stomach is divided by a second contraction into three sacs, of which the third undoubtedly arises from an unusual separation of the cavity of the pylorus from the rest of the cavity of the organ.

All these anomalies are curious, as analogous with animals. They occur principally in females.

When they exist, the texture of the stomach is unaltered in the contracted portion. This circumstance, however, is not sufficient to justify the opinion mentioned at the commencement of the paragraph, that this state constitutes a primitive deviation of formation, and farther, because, as we have already mentioned, the stomach contracts transiently at the same place during digestion, and causes of different kinds might render permanent an arrangement which should be transitory. The greater frequency of this anomaly in females, is equally favourable to the two opinions. We then have reason to think that the contraction in question does not always occur in the same manner, and this conjecture is rendered still more probable, as it is sometimes congenital, and attended with other deviations of formation, which mark an arrest of development.*

Not unfrequently, from a primitive deviation of formation, the stomach is no longer than the intestine, in which case it cannot be dilated.

We might probably mention here a valvular contraction of the left orifice of the stomach, which is very curiously attended with the absence of the pyloric valve.† If, however, this anomaly was not confined to a simple contraction, we ought rather to refer it to the deviations of formation dependent on an excess of the formative power.

3rd. *Shortness.* Occurring sometimes in the whole of the intestinal canal, but most frequently in the vermiform appendix of the cœcum only.

II. SPECIAL DEVIATIONS.

§ 2191. The special deviations of primitive formation are:

1st. In the stomach.

a. The absence of the base, which we have once observed in a child two months old, where the cul-de-sac of the pylorus was much larger than that of the cardia, which was hardly visible.

b. Its perpendicular situation, which does not always depend on the abnormal enlargement of the liver, or on any other mechanical cause.

2nd. In the intestinal canal.

a. The prolapsus of this canal into the umbilical sheath in a case of exomphalos. Instances of this anomaly are most frequent in the small

* Sandifort, *Obs. anat. path.*, vol. iii. p. 11.
† Fleischmann, *Leichenöffnungen*, p. 100.

intestine, as when the development is normal, this portion of the canal enters last into the abdomen.

b. The more or less perfect continuance of its primitive connection with the umbilical vesicle.*

This anomaly exists in several different degrees.

Sometimes the umbilical vesicle continues beyond the usual time, and communicates with the ileon by an open canal which the omphalo-mesenteric vessels† attend.

Sometimes only a canal exists; it varies in length, and extends from the same point of the ileon to the umbilicus, where it opens, and the omphalo-mesenteric vessels also accompany it.‡

Finally, sometimes a greater or less prominence exists in this place, a prolongation termed the *diverticulum of the ileon*, this is often accompanied by the omphalo-mesenteric vessels, which float loosely at its extremity, or which are attached to the umbilicus or to another region of the intestinal canal, so as to form a plexus.

These three anomalies are only different degrees of the same deviation of formation. This is proved by their appearing always in the same place, by their connections with the omphalo-mesenteric vessels, and finally, the insensible shades which each presents in respect to length and size.

That they have the signification we attribute to them is proved, 1st, by our history of the development of the intestinal canal, by their constant co-existence with the cœcum and vermiform appendix, and finally, by the fact, that they always have the character of a primitive formation.

That they depend on a primitive formation is proved by the facts, that they are always observed in the same place, that they are formed by all the membranes of the intestinal canal, and that they exist simultaneously with other primitive deviations of formation, which arise from the development being arrested, or which, at least, favour their productions.

All these circumstances united demonstrate, that it is impossible to regard them purely as accidental productions,§ and consider them as excrescences,|| or as contractions,¶ or hernias** of the ileon.

In fact, the following arguments have been opposed to our theory of the diverticula of the ileon:—

* Meckel, *Beyträge zur vergleichenden Anatomie*, vol. i., pt. i., 1808.—Id., *Ueber die Divertikel*; in Reil, *Archiv für die Physiologie*, vol. ix. pt. iii.—Id., *Handbuch der pathologischen Anatomie*, vol. i. p. 553-597.—Fulling, *Diss. de diverticulo intestinali sex mensium embryonis herniam umbilicalem referente*, Marburg, 1807.—Regnault, *Observation d'un cas singulier de volvulus*; in the *Journ. univ. des sc. Méd.*, vol. ii. p. 108.—P. Rayer, *Cas mortel d'entérite et de péritonite, déterminé par un diverticule de l'iléon*; in the *Archiv. gén. de méd.*, vol. v. p. 68.

† Tiedemann, *Anatomie der kopflosen Missgeburten*, p. 66. tab. iv.

‡ Meckel, in Reil, *loc. cit.*, vol. ix.

§ Oken, in *Jeanær Literaturzeitung*, 1815, no. 35.

|| Fleischmann, *loc. cit.*

¶ Littre, Mery, in *Mém. de Paris*, 1700-1701.

** Fabricius and Morgagni, in Morgagni, *Ep. an. méd.* 34, *a.* 17.

a. Their inconstancy,* their variety,† while all the transitory formations do not entirely disappear when the development is regular, and also the vitelline canal in birds always continues.

b. The existence of several diverticula in the same intestine, or at least that of real diverticula in parts of the intestinal canal beside the ileon.‡

c. Their frequent co-existence with deviations of formation by doubling or arrest of development.§

d. The great size and thickness of their parietes, which even did a canal of the umbilical vesicle exist in the early periods of life, would indicate an excess in the formative power.||

But we have already opposed most of these objections before they were brought forward, and it is easy to refute them.

The first proves nothing, for several other deviations of formation, which consist essentially in the development being arrested, are still more rare than the diverticula, and disappear entirely when the development is regular. We shall mention, for instance, the permanence of the pupillary membrane, the absence of the extremities, the continuance of the arterial canal, the urachus, and the omphalo-mesenteric vessels, the fissure of the uterus. The analogy with birds, which has been adduced, is valueless, since even in several birds, as those of prey, the vitelline canal always seems to disappear entirely, and we commonly observe traces of the primitive state longer in the lower animals than in the higher classes.

Against the second objection, the extreme rarity of the anomaly on which it is founded, may be adduced. Farther, we may ask, if among these extremely rare cases, there are not some false diverticula; if in others, the diverticulum is not produced by distension; if in others, it does not depend on the union of the intestinal canal with the umbilical vesicle at an unusual place; finally, if the deviation of formation cannot be developed as a primitive anomaly, differently from that which commonly occurs, although it is impossible to conclude anything from it concerning this latter.

The third objection favours our views, and is opposed to the theory it is adduced to support; since even where the whole body is double, some organs alone very rarely present the same tendency, for instance, a supernumerary finger or eye is not common in this case; while, on the contrary, the imperfect formations, especially those depending on suspended development, as the fissure of the vertebral column, the skull, the palate, and the abdomen, the deviations in the formation of the heart and the intestinal canal by defect, are then very common phenomena.

* Oken, in *Jenaer Literaturzeitung*, 1815, no. 26.
† Emmert, *Reflexions sur la vesicule ombilicale*; in the *Journ. compl. des méd.*, vol. ii. p. 369.
‡ Emmert, *loc. cit.*
§ *Id.*, *ib.*
|| *Id.*, *ib.*

The fourth objection is not more valid than the other three, since the difference between the thickness of the parietes and the size of the cavity of the diverticulum, depend on the period when the development is suspended, or on other accidental circumstances, which exert their influence afterward. The oval foramen is no less an anomaly, whether it is an inch or a line in diameter, and accidental mechanical influences may sometimes enlarge it during life.

c. The great size of the vermiform appendix, depending on its continuing to increase after the type of the fœtus, although this anomaly may be developed at a later period.

§ 2195. The deviations of formation, which essentially consist in an excess of the formative power, are much more rare than those we have mentioned.

We should probably consider as such the division of the duodenum into two canals, the existence of two vermiform appendices, doubtless, also, the unusual length of the intestinal canal, instances of which are seen particularly in the large intestine, and which render it more or less tortuous, and especially render the transverse colon pendant.* Perhaps we must also refer to this class the real diverticula which occur in other unusual points, although we have every reason to think that they should be considered as belonging to those deviations of formation relating to the quality.

§ 2196. The primitive deviations of formation which concern the quality, relate to the form or situation, or to both. Among the latter, we must arrange the lateral inversions of the stomach and intestinal canal, since in this case the parts are not only situated opposite their usual place, but also present a figure the inverse of that they normally possess.

The form of the stomach or the intestinal canal, rarely presents primitive deviations of formation in respect to quantity; and the examples known of them may all be referred to anomalies in the diameter.

The situation of the stomach is sometimes changed, this viscus being turned on itself so that its convex edge looks upward, and its concave edge downward.†

B. ACCIDENTAL DEVIATIONS OF FORMATION.

§ 2197. The accidental or consecutive deviations of formation relate to the extent, the mass, the situation, or the form.

1st. Extent.

a. Excess in extent rarely occurs in the whole abdominal portion of the alimentary canal, but it is observed in all its parts, and it is produced by very different causes, that is, particularly by obliteration,

* P. Monterossi has figured a great many cases of this kind at the end of a memoir *on the unusual curves of the large intestine, considered as the cause of death in new born children*, in Brera, *Nuovi commentari di medicina*, 1819, vol. iv. p. 3.

† Fleischmann, *loc. cit.*, p. 98.

contraction, atonia, the latter always from an accumulation of substances within it.*

The abnormal distension of the vessels of the alimentary canal, which not unfrequently exists, deserves to be mentioned here. It is most generally observed in the rectum, in the form of rounded tumours, which project into the cavity of the intestines, and are termed *hæmorrhoids.*† It is generally admitted that these tumours are situated in the hæmorrhoidal veins; doubtless, also, the arteries contribute to them, although we cannot admit with Cruveilhier, that they are new formations, an accidental development of the erectile tissue. More probably they depend in some cases on the dilatation of the small vessels, and in others on that of the larger vessels, and in the last case, where they appear as sacs, the dilated portion is separated from the rest of the vessel.

The vessels of the stomach are generally dilated in melena, and the black substance vomited, or which is found in the stomach, is blood more or less changed, which has transuded through their extremities.

b. Abnormal contractions, when not primitive, are rarely confined to a simple deviation of formation. They generally succeed alterations of texture, inflammation, and its consequences, effusion, scirrhus, &c. The first commonly occurs when the alimentary canal is not distended by the causes which habitually act upon it, consequently after long fasts.

The whole canal is affected. A contraction also occurs in a portion of this canal situated below a solution of continuity which entirely divided it, consequently when an artificial anus is formed after a wound or strangulated hernia.

2nd. We more seldom find an increase or diminution in *mass* without an alteration of texture; the first occurs particularly in the muscular tunic, and supervenes when this membrane has been unusually exercised. Thus it is more rare to find the stomach dilated than very muscular in gluttons. The muscular membrane is similarly changed in a herniary portion of intestine.

The muscular tunic becomes much thinner in a general loss of flesh.

3rd. *Situation.* Deviations in situation should be referred to the chapter on hernias, since they generally occur in these affections. The small intestine is particularly liable to a change in its situation, on account of its greater mobility, its smaller size, and its situation. Next comes the stomach, which generally emerges through the linea alba or the upper part of the abdominal muscles, sometimes, however, through the umbilical ring. When abnormal openings exist in the

* Chaussier, *Observation suivie de reflexions sur une dilatation excessive de l'estomac*; in the *Bulletin de la soc. méd. d'émul.*, 1823, September, p. 505.

† Montegre, *Des hémorrhoides*, or *Traité analytique de toutes les affections hémorrhoidales*, Paris, 1819.—E. Summe, *Diss. de hæmorrhoidibus cæcis*, Berlin, 1820.

diaphragm, they allow the stomach to pass into the cavity of the thorax.

4th. The principal changes in form are:

a. Inversion, in which one portion of the intestine is turned, so that its inner face becomes the external, and the outer face the internal. When this change occurs at the lower part of the rectum, it is termed a *prolapsus ani*. In every other part it is called *intussusception* or *invagination*, because the inverted part enters that below it. The first state is more simple, since the portion of intestine which forms hot prolapsus is composed of two parts, situated one on the other, the external of which is reversed and the internal is normal, while in the second case is added a third, that into which the inverted portion enters. Sometimes we find a still greater number of superimposed layers, there being two invaginations, one within the other.

Several invaginations often occur at the same time.

They are most frequently situated in the small intestine, undoubtedly because it is the most moveable portion of the alimentary canal.

Even those intussusceptions which commence very high may descend into the rectum and emerge from the anus.

The most common cause of this state is the irregular action of the muscular membrane. Sometimes, however, it is caused mechanically by tumours, which force a portion of the intestinal canal downward and inward.

Slight invaginations are doubtless not dangerous, and disappear of themselves; but when they exist to a greater extent they cause inflammation and gangrene of the herniary portion, which is usually, but not always, attended with death; sometimes, however, the gangrenous portion sloughs off, and the space is filled by adhesive inflammation.

5th. Solutions of continuity result either from mechanical influence, as the action of a cutting instrument, a rupture, or from a previous alteration of texture, as from ulcerations. They are sometimes complete, and then effect all the tunics, sometimes confined only to the muscular and peritoneal membranes, whence results a hernia of the inner membrane, and the formation of a rounded tumour termed a *false diverticulum* (*d. spurium*). The false differs from the true diverticulum by its rounded form, by the absence of several superimposed tunics, and finally by its occurring in every part, even in the stomach, but most frequently in the duodenum, and by the existence of several at once.*

II. ALTERATIONS OF TEXTURE.

§ 2198. We not unfrequently observe an alteration in the texture of the intestinal canal, particularly in the stomach, which is its *softening*

* We have enlarged upon this subject in our *Handbuch der pathologischen Anatomie*, vol. ii., p. 11.

or *thinness*, and when occurring in a still greater extent its *perforation*.* This alteration is seen particularly in the large cul-de-sac and in the posterior wall of the stomach, and commences by the inner membrane, which always appears very red in this place. The edges of the perforation are very irregular, and differ from those of a perforation caused by an ulcer by the total absence of thickening and hardness of the edges, which are, on the contrary, very thin and soft. Sometimes this change supervenes after death; sometimes it occurs during life, but in both cases it is caused by the action of the gastric juice on the stomach, and we may consider it as resulting from the digestion of the membranes of the stomach by this juice, which effect results when the perforation occurs during life from some change in the chemical composition of the gastric fluid.†

* Chaussier has given a good description of perforations of the stomach; we shall quote his words. Ulcerations and perforations of the stomach vary in form, situation, and extent. They are small and circular, or large enough to introduce the hand into them. They may occur in any part of the stomach, but are seen particularly at the base of this organ, in the portion corresponding to the spleen and diaphragm. Sometimes then the food enters into the abdomen, or the thorax if the diaphragm be perforated. But most generally there is no effusion, the ulcerated portion of the stomach being connected with the adjacent parts. If we destroy these adhesions, which are slight, a viscous, and sometimes a fluid, flows from the stomach, which is not fœtid, and sometimes has an odour like musk; it is always brownish, and mixed with blackish flocculæ or molecules, as if finely pulverized charcoal was strewed in mucous serum. The edges are soft, broken, and sometimes surrounded with a more or less marked blackish line. In every other part the stomach preserves its usual form and consistence. It no where presents marks of engorgement or inflammation: only the capillary plexuses of its follicular membrane seem to be more developed, especially around the perforation. Sometimes these changes form suddenly in a few hours in healthy persons; most generally, however, after several days of sickness, and when no violent external cause or poisoning can be suspected (*Bulletin des sciences médicales du département de l'Eure*, no. 53. p. 7). Consult also on this subject which relates to one of the most important questions in legal-medicine: Gerard, *Des perforations spontanées de l'estomac*, Paris, an. xii.—Morin, *Considerations générales sur l'érosion*, Paris, 1806.—G. Laisne, *Considerations médico-légales sur les érosions et perforations spontanées de l'estomac*; in the journal called *Médecine légale*, Paris, 1819, p. 135.—J. Cloquet, *Sur les perforations intestinales*; in the *Nouveau journal de médicine*, vol. i. p. 107.—Serres, *Observation d'une perforation de l'œsophage*; in the *Revue médicale*, vol. x. p. 166.—Id., *Observations de perforations intestinales*; same journal, vol. x. p. 170.—E. Legallois, *Plusieurs perforations du canal intestinal et spécialement des gros intestins, à la suite d'une affection tuberculeuse*; in the *Archiv. gén. de méd.*, vol. vi p. 68.—Louis, *Du râmollissement avec amincissement et de la destruction de la membrane muqueuse de l'estomac*; same journal, vol. v. p. 5.—Abercrombie, *Observations sur l'inflammation et l'ulcération de l'estomac*; same journal, vol. v. p. 447.—Louis, *Observations relatives aux perforations spontanées de l'intestin grêle, dans les maladies aiguës*; same journal, vol. i. p. 17.—U. Coste, *Observations sur les perforations de l'estomac*; in the *Journ. univ. des. sc. méd.*, vol. xxix. p. 257. F. T.

† This is the opinion of Hunter. We cannot admit it. It rests on Hunter's opinion in accordance with that of Spallanzani, in respect to the gastric juice. But it is very evident that the gastric juice does not exist, as these two physiologists have supposed, that it does not accumulate in the stomach between meals, that it is secreted only at the moment when the viscus is filled with food, that this secretion is caused by the impression produced by the latter, and so far from being identical, it always varies according to the nature of the substances from which the chyme is found. Besides, perforation of the stomach has never been observed in the cases of death by starvation hitherto observed, and that cited by Hunter should be referred

When the stomach is thus destroyed in one part, the softening produced by the effused fluid extends also to the adjacent portions.*

§ 2199. The alimentary canal frequently *inflames*,† especially in its mucous membrane.

In regard to the inflammation of the stomach, we ought to remark that the inner membrane of this viscus, which is the most subject to inflammation on account of the numerous vessels it receives, the formative power it possesses, its connections with the skin, and the direct effect of deleterious substances upon it, often presents, when not inflamed, a very deep red colour, which depends on an accumulation of blood in the small twigs of the veins, and is observed particularly after death, from those causes which favour the stagnation of blood in these vessels by opposing its return to the heart.

In inflammation of the mucous membrane, the mucus becomes thicker and firmer. At the same time the fibrin is effused on the inner face and in the substance of this membrane. The result of the first of these phenomena is, the formation of more or less thick, hollow, or solid cylinders, which pass off from the anus, and which have been wrongly considered as the membranes of the intestine. The effect of the second is, to thicken the parietes, and thus to contract the cavity of the canal. In the latter case partial adhesions sometimes, but rarely, occur, and probably arise from ulcerations.‡

In ulcers of the mucous membrane, the edges are usually lightly turned over, uneven, and hard; sometimes also their edges are smooth, and, as it were, cut.

Inflammation and suppuration frequently form *fistula of the anus* (*fistula ani*), that is, a canal which commences on the inner face of the rectum, descends on its sides, and terminates near the anus. Like all fistulous passages, this canal is covered internally by an epidermis, similar to the mucous membranes, and is surrounded with a dense cellular tissue.§

In dysentery, where the inflammation is situated principally in the mucous membrane of the large intestine, especially of the rectum, this membrane frequently mortifies in several parts, and black and dry eschars are formed on its surface.

to the erosions mentioned in the preceding note. Consult on this subject F. G. Gœdecke, *De dissolutione ventriculi, sive de digestione quam dicunt ventriculi post mortem*, Berlin, 1823.

* Yelloly, *Observations on the vascular appearance in the human stomach, which is frequently mistaken for inflammation of that organ*; in the *Med. chir. trans.*, vol. iv. p. 374-425.

† Scoutetten, *Recherches d'anatomie pathologique, démonstrant le rapport qui existe entre l'irritation de la membrane muqueuse du canal intestinal et celle de la méningine*; in the *Journ. univ. des sc. méd.*, vol. xxviii., p. 257.

‡ Monro, *Morb. anat.*, tab. vii.

§ J. Howship, *Practical observations on the most common diseases of the lower intestines and anus*, London, 1820.—C. Bell, *A treatise on the diseases of the urethra, vesica urinaria, prostata, and rectum*, London, 1820.—T. Copeland, *Observations on the principal diseases of the rectum and anus*, London, 1814.

All these phenomena are usually confined to the mucous membrane. The tubercular formation, however, in which rounded, whitish, and hard masses are formed, extends from this membrane to the outer face of the organ, where it forms more or less evident prominences. This change is commonly observed in the latter period of tuberculous phthisis, especially in the small intestine. The ulcerations thus affect all the membranes of the stomach, and then gradually extend from within outward. They do not necessarily result in the effusion into the abdomen of substances contained in the organ; this is even proportionally rare on account of the adhesions with the adjacent parts, or because the opening communicates with another portion of the intestinal canal, or with the exterior, when the wall of the abdomen adheres to the diseased organ.

Inflammation of the peritoneal coat of the alimentary canal is often followed by more or less general and intimate adhesions between the different parts of the passage. These adhesions are sometimes so numerous and intimate that the folds of the intestines form one mass, which cannot be separated from the surrounding substance, and represents only a canal hollowed in an amorphous mass.

One of the most common alterations of texture in the intestinal canal is the scirrhous formation, which extends from the vascular tunic and the muciparous glands, where it is primitively situated, to the mucous and muscular membranes. It blends together all these tunics, and renders them thicker and harder; they finally present a carcinomatous ulceration.* This alteration of structure causes a contraction of the canal, which is often very great. It is observed more particularly in the pylorus, the end of the descending colon, and the rectum, which depends perhaps only on the disposition of these parts to retain for a longer period the substances which pass through them, and are also more exposed to irritation and its consequences. But the morbid affection extends also a greater or less distance to its primitive source, so that it sometimes attacks the whole stomach and a very great portion of the intestinal canal.

Very probably we must arrange here the morbid alterations described by Monro, in which albumen is deposited in the vascular tunic, for all its essential characters are the same, and it differs from cancer only in its form, since it appears as small rounded bodies.†

The fungous excrescences of the mucous membrane are much more rare. They have however been found in every part of the intestinal canal. Thus authors have described some cases of very large polypi of the stomach, one of which extended from the cardiac orifice even within the duodenum.‡ We have lately found in the cadaver of a

* Bourdon, *Observations sur quelques maladies de l'estomac*; in the *Revue médicale*, May, 1824.

† *Morbid. anat.*, p. 17.

‡ Breschet, *Tumeur polypeuse développée dans l'estomac*; in the *Bull. de la fac. de méd.*, vol. v., 1817, p. 376. Other cases of this kind may be found in Monro, *Morbid anat.*, tab. vi.—Fabre, *Gazette de santé*, June, 1815.

young man frequently affected with abdominal affections, and who died of violent enteritis, two excrescences of the mucous membrane of the small intestine, one of which was about four lines in diameter, and was covered in all parts by the mucous membrane, while the other, about an inch in diameter, had destroyed this membrane, and was unattached. These excrescences are more common in the rectum* than in any other part. They are similar only in form, for they differ much in respect to texture; since they are sometimes very hard and solid, sometimes spongy, and of a loose and soft tissue. The first probably belong to the class of fibro-cartilages, and the others to that of fungous hematodes.

A tumour of the internal membrane, described by Monro as a *milt-like* tumour, and which affects the stomach particularly, is doubtless a fungus hematodes.†

In fact, in examining the viscera of individuals who have died from a severe attack of small-pox, we have found the inner membrane of the intestinal canal very red, but have never seen in it pustules.

The normal tissues are rarely formed abnormally in the intestinal canal. We must however mention here, the fatty tumours developed on the inner face of the mucous membrane,‡ the hairs which are found sometimes alone on the inner face of the intestine,§ sometimes attended with teeth, in the stomach,|| the ossifications of the inner face of the intestine,¶ and finally, at least in certain cases, hemorrhoids, when they are cavernous formations.

§ 2200. *Foreign bodies* of different kinds are common in the abdominal portion of the alimentary canal, particularly in the intestine.

Those seen most frequently are the intestinal worms, which in fact are more common here than in any other part of the body. The ascaris lumbricoides, the tœnia lata, s. bothryocephalus latus, and the tœnia solium, live principally in the small intestine, the trichocephalus dispar in the large intestine, and particularly in the cœcum, finally the ascaris vermicularis, oxyuris vermicularis, Bremser, in the large intestine, and particularly in the rectum.

These worms exist in the stomach only accidentally, and generally even not till after death. The openings through which they sometimes pass into the peritoneal cavity are not formed by them.

Other foreign bodies, which are much more rare, are concretions introduced accidentally into the intestinal canal. They are most

* Meckel, *Handbuch der pathologischen Anatomie*, vol. ii., pt ii., p. 511.—Laracine, *Observation sur une tumeur fongueuse pédiculée dans le rectum*; in the *Bull. de la soc. méd. d'émul.* September, 1821.

† *Morbid anatomy*, p. 160.—Rullier, *Sur le cancer de l'estomac*; in the *Archiv. gén. de méd.*, vol. ii., p. 380.

‡ Meckel, *Handbuch der pathologischen Anatomie*, vol. ii., pt. ii., p. 124.

§ Meckel, *Mémoire sur les poils et les dents qui se développent accidentellement dans le corps*; in the *Journ. compl. des. sc. méd.*, vol. iv., p. 122, 217.

|| Ruysch, *Advers. anat.* dec. iii.

¶ Meckel, *Handbuch der pathologischen Anatomie*, vol. ii., pt. ii. p. 227.

commonly biliary calculi, which descend into it from the gall bladder. Next come the abdominal concretions, which form partially or wholly in the intestine.*

ARTICLE FOURTH.

GLANDULAR ORGANS OF THE ABDOMINAL PORTION OF THE DIGESTIVE SYSTEM.

§ 2201. The glandular organs of the abdominal portion of the digestive system,† termed also, together with the stomach, the *chylopoietic viscera* (*viscera chylopoietica*), are the *liver*, the *pancreas*, and the *spleen*. They are situated in the upper half of the abdomen, and are intimately connected with each other, and with the stomach and the duodenum, not only in situation but also in the vessels and nerves they receive, but even, except in the spleen, in continuity of substance. In fact they receive their vessels from the same trunk, the cœliac artery; their nerves come from the same source, the solar plexus; finally, the excretory canals of the liver and pancreas, which open into the duodenum, are in fact folds of the inner membrane of this intestine.

I. LIVER.

A. PERFECT STATE.

A. SITUATION.

§ 2202. The liver (*hepar, jecur*),‡ the largest gland in the body, occupies all the right hypochondriac region, the upper part of the epigastric region, and in the female particularly, part of the left hypochondriac region. It descends on the right side lower than on the left,

* Meckel, *Remarques sur les concrétions qui se recontrent dans le canal intestinal chez l'homme*; in the *Journ. compl. des sc. méd.*, vol. ii. p. 125.

† J. Fantoni, *De jecore, liene et pancreate*; in the *Disc. renov.*, Turin, 1745.

‡ A. Rolfink, *De hepate*, Jena, 1633.—F. Glisson, *Anatomia hepatis*, London, 1654.—M. Malpighi, *De hepate*; in the *De viscerum structura*, Bologna, 1666.—J. B Bianchi, *Historia hepatica*, Turin, 1711.—A. Bertrandi. *De hepate et oculo*, Turin, 1748.—A. Franken, *Hist. hepat. anat.*, Leyden, 1748.—J. G. Gunz, *Obs. circa hepar*, Leipsic, 1748.—A. Ferrein, *Sur la structure des viscères nommés glanduleux, et particulièrement sur celle des reins et du foie*; in the *Mém. de Paris*, 1749, p. 709.—M. Ambodick, *De hepate*, Strasburgh, 1775.—F. A. Walter, *De structura hepatis et vesiculæ fellæ*; in the *Annot. acad.*, Berlin, 1786.—Saunders, *A treatise on the structure, economy, and diseases of the liver*, London, 1798.—J, M. Mappes, *Diss. de penitiori hepatis humani structura*, Tubingen, 1817.—Id., *Quelques considérations sur la structure du foie et du rein*; in the *Journ. compl. des. sc. méd.*, vol. xii., p 223.—J. F. Beltz, *Quædam de hepatis dignitate*, Berlin, 1822.

so that it is situated obliquely from below upward, and from right to left. On the left side it terminates near the upper extremity of the spleen; its left portion covers the stomach, the right generally the whole right kidney, but when the latter organ is situated lower than usual, only its greater upper half.

B. DIMENSION AND WEIGHT.

§ 2203. The transverse diameter of the liver in the adult is usually from ten to twelve inches; the antero-posterior is from six to seven inches. The gland is two inches high in its thickest portion.

The liver generally weighs about four pounds in the adult, so that its weight in proportion to that of the whole body is as 1 : 36.

C. FORM.

§ 2204. The form of the liver is irregular and quadrangular. It is much thicker from one side to the other than from before backward, and is thinnest from above downward.

§ 2205. The liver is generally divided into two *halves* or *lobes* (*lobi*), the right and the left, separated on the upper face by the suspensory ligament, on the anterior edge by a deep groove, and on the lower face by a deep longitudinal fissure, which extends the whole breadth of the gland.

§ 2206. The *right lobe* (*l. hepatis dexter*, s. *major*,) is about four times as large as the *left* (*l. hepatis sinister*, s. *minor*), and much exceeds it in all its dimensions, but particularly in its thickness.

Its upper face is uniformly convex; the lower presents elevations and depressions which render it very uneven.

These inequalities are connected with the blood vessels, the lymphatics and the biliary vessels which enter or emerge from the liver, and correspond to the *fissures* (*hilus*) of the other glandular organs.

The two edges of the liver, the *anterior* or *inferior*, and the *posterior* or *superior*, are generally convex, but the first is more so than the other. The anterior is thin and sharp, the posterior thick and blunt, so that the upper and lower faces gradually unite in that part, although there is a very distinct limit between them.

The left portion of the lower face of the right lobe, which is the smallest, and which occupies the centre of the lower face of the liver, considered as a whole, has the form of an H inclined from before backward, the transverse bar and the two legs of which are formed by the *fissures* (*sulci*, s. *foveæ*) which converge behind the lower face of the liver, between which are the *elevations* (*lobuli*).

§ 2207. The *transverse* or *median fissure* (*sulcus intermedius*, s. *transversus*) is situated about the centre, a little nearer the posterior than the anterior edge. We notice in it the commencement of the *excretory*

duct of the liver, or the *hepatic canal* (*d. hepaticus*), the commencement of the arterial portion of the vena-portæ and the hepatic arteries. The hepatic canal is situated entirely forward, the vena-portæ between an anterior and a posterior series of branches of the hepatic artery. Each of these three vessels divides into a right and a left branch; from the hepatic artery are commonly formed two, which are entirely distinct, a right and a left.

§ 2208. The *left longitudinal fissure* (*fossa longitudinalis sinistra*), which separates the right from the left lobe, extends from the anterior to the posterior edge. The left extremity of the vena-portæ divides these into halves, an anterior, longer and deeper, and a posterior, smaller and more superficial.

The anterior half (*fovea-pro vena umbilicali*, s. *lig. terete*) is the groove for the umbilical vein or the round ligament of the liver.

Gunz has asserted, contrary to most anatomists, that this anterior half is most generally changed into a real canal, as in almost all animals, by one or more bands of the substance of the liver, which extend like a bridge from the lower face of the great lobe to that of the small, and are sometimes also replaced by a simple prolongation of the peritoneal capsule of the gland.

The posterior half of the left longitudinal fissure, which is more superficial than the anterior, especially toward the left lobe, is the fossa for the venous canal (*fossa pro ductu venoso*), which is there directed from before backward, from below upward, and near its termination a little from left to right.

It is continuous posteriorly with the fissure of the ascending vena-cava.

We rarely find it intimately united with the venous canal by a layer of the substance of the liver, which is then very thin.

§ 2209. The *right longitudinal fissure* (*fossa longitudinalis dextra*) is much more superficial, and its anterior part, separated from the posterior by the vena-portæ, differs much from this latter in form and in importance.

The anterior is plainer and is not covered by the peritoneum, it receives the gall-bladder (*fossa pro vesiculâ felleâ*). This depression is most generally indicated forward by a greater or less groove, and sometimes it communicates near its anterior extremity with the upper face of the liver by an opening.

The posterior is directed from below upward, and is continuous with the posterior edge; it is termed the *fossa of the vena-cava* (*fossa venæ cavæ*), because it receives the upper part of the ascending vena-cava. It blends posteriorly in the blunt edge of the liver with the fissure of the venous canal. It is rarely wholly or partially changed into a canal by a band of the substance of the liver.

About twenty small hepatic veins proceed from this fossa from below upward, in pairs side by side, and empty into the ascending vena-cava; but from its upper part arise two large venous trunks, a right and a left, which terminate in the same manner.

Thus the vena-cava follows, in the arrangement of its branches, the same law as the other vessels of the liver, and although the latter is a simple organ, it seems composed of two halves, a right and a left.

Its vascular fissures are separated from each other on the lower face by the posterior middle lobe; they however blend together posteriorly.

§ 2210. The portion of the lower face of the liver, situated between the two longitudinal fissures, is divided by the portal eminence into two halves, an anterior and a posterior.

The anterior, which is deeper, is situated between the depressions of the gall-bladder and the umbilical vein on one side, and the portal eminence and the anterior edge on the other, and has been called from its form the *square lobe* (*l. quadratus*).

The posterior is smaller, more elongated, narrower, but more prominent, because situated on a narrower base, is found between the portæ, the fissure of the ascending vena-cava, that of the venous canal, and the posterior edge. It is termed the *lobe of Spigel* (*lobulus Spigelii*, s. *caudatus*).

§ 2211. The right portion of the lower face of the great lobe is the most extensive and thickest, and is uniformly convex or concave.

§ 2212. The left lobe, which is much smaller and thinner, gradually terminates in a blunt extremity. Its upper and its lower faces are smooth and united.

Beside the fissures we have described, we not unfrequently find, particularly in the right lobe, several which vary in size and are not constant; these are analogous to the division of the liver into many lobes in the mammalia.

D. ATTACHMENTS.

§ 2213. The liver is enveloped by the peritoneum, except the right part of its posterior edge and the portion of its lower face covered by the gall-bladder. This membrane is reflected on it backward by its blunt edge, and forward by the portal eminence or the suspensory ligament. There is no other envelop between it and the tissue of the gland in most of its extent; we however find an intermediate layer of cellular tissue at the posterior part of the upper face near the edge.

§ 2214. The liver is kept in place by several folds of peritoneum, namely:—

1st. By the *coronary* ligament, at its posterior edge.

2nd. By the *right* and *left triangular* ligaments, which form its right and left extremities, to the lower face of the diaphragm.

3rd. By the *suspensory* ligament, which is attached to the lower face of the diaphragm and to the linea alba.

The small epiploon unites it to the small curve of the stomach.

A short cellular tissue also unites it very loosely to the right kidney, which it receives in a depression of the lower face of its right lobe.

E. COLOUR, SPECIFIC GRAVITY, AND CONSISTENCE.

§ 2215. The colour of the liver is brownish red in young persons and those in the prime of life. It becomes darkish and blacker in old age. Its specific gravity is about as 15 : 10.

Its substance is firm, but brittle. Thus the liver is one of the organs most frequently ruptured, from a mechanical cause acting on the parietes of the abdomen when the external parts are uninjured.

F. TEXTURE.

§ 2216. The parenchyma of the liver is not absolutely homogeneous. In fact we do not find, as in the other glands and the encephalon, the two substances of which it is composed separated from each, so that one is placed internally and the other externally. But whatever point we examine, these two substances, which are every where arranged alternately, are easily distinguished. At first view they seem to form undulated bands about half a line thick; but when examined more attentively we perceive that the yellow forms a coherent mass in all parts of the gland, that it there produces numerous elevations and depressions, although interrupted in many parts, and consequently represents a very complicated net-work. In the spaces, which are about a line in diameter, and which are polygons, we find a dark substance which does not form a coherent whole like the preceding, and which is softer but less transparent than it.

Ferrein had already well distinguished these two substances.* Haller† and Gunz‡ also mention its discovery. Autenrieth,§ Bichat,‖ Cloquet,¶ and Mappes,** have also mentioned this structure, which we have always thought was easily seen; hence we consider as erroneous the opinion†† that they are arranged arbitrarily. Physiologists, however, differ in regard to their uses. Ferrein terms the deep coloured substance the *medullary*, and the bright coloured substance the *cortical*; while Autenrieth and Mappes have applied these terms in opposite senses. The views of these last two writers seem to us to be more just than those of the others regarding the difference in the consistence and the transparency of the two substances, in respect to their colour, or finally their arrangement in regard to continuity, since in all these respects the bright substance is more similar

* *Mém. de Paris*, 1735, hist. 51.

† *Bibl. anat.*, vol. ii., p. 253.

‡ *De hepate*, p. 28.

§ *Ueber die Rindensubstanz der Leber*; in Reil, *Archiv. für die Physiologie*, vol. vii., 1817, p. 299-308.

‖ *Anat. descript.*, vol. v., p. 03.

¶ *Traité d'anat.*, vol. ii., p. 1032, 1033.

** *Loc. cit.*, p. 6.

†† Portal, *Anat. prat.*, 1804, vol. v., p. 278.

to the bright substance of the encephalon, the spinal marrow, and the kidneys; and the dark substance to the cortical substance of these latter.

When the yellow medullary substance is examined attentively, it seems formed of small points or grains.

We may term the small masses composed of medullary and of cortical substance the *lobules* (*acini*), although they are more blended than in the other glands, and are not separated by spaces filled only with cellular tissue; so that the structure of the liver is consequently much less lobular than that of the salivary glands.

From the consistence and hardness of the substance of the liver, the orifices of the vessels which are intimately united with it remain gaping when it is cut.

§ 2217. The liver is formed by the ramifications of the biliary ducts, of the vena-portæ, of the hepatic artery and the hepatic veins, and by lymphatic vessels and nerves, united by mucous tissue. It is, however, essentially formed by the biliary vessels and the mucous tissue which surrounds them.

§ 2218. The vessels of the liver are not all distributed exactly in the same manner. They vary in their connections with each other, and with the substance of the organ.

The hepatic artery, the vena-portæ, and the biliary ducts are enveloped in their whole course through the substance of the liver by a common cellular sheath, a prolongation of the capsule of Glisson. Hence they are not in direct contact with the substance of the gland, like the ramifications of the hepatic artery, around which the capsule does not exist, and they are more solid and more resisting than the latter.

The hepatic artery seems to be intended for the nourishment printcipally of the tissue of the liver; for according to Glisson's observaaions,* which have since been proved correct by Bianchi,† Walter,‡ tnd Mappes,§ it is distributed on the other vessels, giving rise there to a very complex net-work. The finest ramifications, however, enter the vena-portæ.‖

Its branches are fewer and straighter than those of the latter.¶

When injected it is generally entirely filled, but sometimes this is lrue only of the vena-portæ.**

§ 2219. The vena-portæ forms by far the largest part of the vascuar substance of the liver. It ramifies very frequently, and evidently

* L. i., c. xxix., *De arteriæ hepatis distributione.*
† *Loc. cit.*, pt. i., cap. viii., § 5.
‡ *Loc. cit.*, p. 96.
§ *Loc. cit.*, p. 13.
‖ Walter, p. 96, 99.
¶ Id., p. 95, 96.
** Id., p. 68.

like a disk, although one of the two branches is much larger than the other.*

It terminates in two modes; several branches, some of which are very large and even a line in diameter, anastomose with the corresponding twigs of the hepatic veins,† and hence the facility with which the vena-portæ is injected through these latter, or the hepatic veins through the vena-portæ.‡ Other and more minute branches are more particularly connected with the origins of the biliary ducts; but their connections are less intimate than those we have mentioned, since by injecting the vena-portæ we can never fill the biliary canals alone, but the injection always passes into the other vessels, particularly into the hepatic veins.§ Its most minute twigs do not enter into the medullary substance of the liver, but are distributed in the cortical substance, and have no direct or proximate connection with the first.‖

§ 2220. The biliary canals differ from the other vessels of the liver, as their twigs are larger. Only the large branches unite in the manner of a disk. The union of the small twigs is less regular, and several proceed from the same point. Their parietes are much firmer than those of the veins. The muciparous depressions upon their inner face on the outer half of the liver do not exist except in the largest branches, and entirely disappear in the most minute, which are perfectly smooth. When they are injected, the injection generally penetrates into no other kind of vessel, or when this happens the lymphatics,¶ and next the branches of the vena-portæ, are most perfectly and frequently filled.

The roots of the biliary canals seem to arise on the limit between the medullary and the cortical substance, although they do not distinctly pass through the former.** They never terminate on the surface of the liver, and even when they are superficial, they penetrate within the gland.

§ 2221. The twigs of the hepatic vein are also fewer and larger than those of the vena-portæ and the hepatic artery. They do not contribute as much as the vena-portæ to form the substance of the liver,†† although their less degree of development is only apparent, since their twigs are so small, that they are more easily destroyed than the other hepatic vessels. When injected, the fluid scarcely passes, excepting into the vena-portæ.‡‡ Their direction is generally transverse, while that of the other hepatic vessels is oblique from below upward, and almost perpendicular, so that they cross these

* Mappes, p. 13.
† Bertin, in the *Mém. de Paris*, 1765.—Walter, p. 94, 95.
‡ Walter, p. 63.—Mappes, p. 23.
§ Id., p. 64, 65.—Mappes, p. 22.
‖ Mappes, p. 11-13.
¶ Walter, p. 70.—Mappes, p. 24.
** Mappes, p. 1.
†† Walter, *loc. cit.*.
‡‡ Glisson, p. 285.

latter. Their final twigs are more intimately connected with their medullary substance than those of the other hepatic vessels, and it is more or less easy to trace them into this substance, which depends partly on their not being surrounded like these latter by the cellular capsule.

§ 2222. The lymphatics of the liver are intimately connected with the biliary ducts, and their cavity directly communicates with them, or at least the substance between them is extremely thin, soft, and easily destroyed. Those of the different regions of the liver do not anastomose together, for the injection of one branch fills only the portion of the organ to which this branch is distributed.

B. EXCRETORY PORTION OF THE BILIARY SYSTEM.

§ 2223. The excretory portion of the biliary system includes the proper *excretory duct* of the liver. and a cul-de-sac of this canal termed the *gall-bladder* (*cystis*, s. *vesicula fellea*, *cholecystis*).

A. EXCRETORY DUCT.

§ 2224. The *excretory duct*, of which we have already described the portion within the liver, is formed by two membranes, one external, solid, and cellular, the other internal, thicker, and smooth, presenting numerous and very compact depressions. We distinguish in it three portions, the *hepatic* canal, the *cystic* canal, and the *ductus choledochus*.

The *hepatic* canal (*d. hepaticus*), or the first portion of the excretory duct, arises in the fissure of the vena-portæ generally by two branches, one on the right, which is smaller, and comes from the anterior part of the great lobe of the liver, the other on the left, which is larger, and arises from the posterior part of this lobe, and from the left lobe. These two branches anastomose at an acute angle before leaving the fissure of the vena-portæ. The canal formed by their union is from one and a half to two inches long, and nearly two lines broad in the normal state ; it is directed from above downward, and from right to left, and divides to give rise to the cystic canal and the ductus choledochus, which make a part of it.

The *cystic canal* (*d. cysticus*) is directed at an acute angle forward, downward, and to the right. It is narrower, and usually a little longer than the hepatic, and enlarges to form the gall-bladder.

B. GALL-BLADDER.

§ 2225. The *gall-bladder* is situated in a special depression of the lower face of the liver. It is usually pear-shaped. The extremity, near its orifice, termed the *neck* (*cervix*), is the narrowest part ; it is broadest in its centre. Its anterior extremity terminates in a cul-de-sac, and is called the *base* (*fundus*) ; it commonly extends a little beyond the anterior edge of the liver. The gall-bladder generally

adheres intimately by its upper part to the lower face of the liver, but sometimes also it is loosely united with it by a fold of the peritoneum. The peritoneum covers it more or less perfectly, according as it presents one or the other of these two arrangements.

We find below the peritoneum a dense cellular tissue, in which proceed the large vascular trunks, and which is called the vascular or nervous tunic. The external face of the second tunic presents some fibres which are generally whitish, proceed in different directions, sometimes very analogous to those of the muscular coat of the intestinal canal, and which cannot be considered as forming a distinct layer.

The cellular tunic covers the internal or mucous membrane, the inner face of which presents folds which represent a reticular tissue, formed of irregular pentagons, which do not disappear even when the gall-bladder is in its greatest possible state of distension. Some very small openings, which are observed on this face, lead to simple glands which are commonly invisible. Only ramifications of veins are distributed on the surface of the folds.

The cystic canal and the neck of the gall-bladder are contracted by about a dozen transverse folds, which are real valves, and arise from the internal and cellular tunics. Most of these folds have their loose edge turned toward the cavity of the gall-bladder, so as to form between them and the wall of the canal a depression which has the same direction.

These folds gradually enlarge from the hepatic canal toward the neck of the gall-bladder. They are attached to each other, especially the largest, by intermediate, longitudinal, oblique elevations, which are less prominent.

§ 2226. The *ductus choledochus*, or the lower portion of the excretory canal of the liver, is the continuation of the hepatic and the cystic ducts. It is a little broader than these two canals, but it is more similar to the hepatic in structure and diameter, and may be considered the direct continuation of it, for it has the same direction, and there exists, at least very frequently, along the opening of the cystic canal, a small elevation between it and these two passages.

This canal is generally about four inches long; its lower extremity goes to the posterior wall of the duodenum, and opens at its central portion. Its diameter is generally the same until it opens into the intestine, but it contracts much in gliding between the muscular and cellular tunics of the latter, and finally terminates in an orifice which is narrower than the rest of its course.

§ 2227. When we cut the duodenum, we observe in the posterior wall the opening of the ductus choledochus, in the form of an oblong tubercle, about four lines in length, and presenting at its lower extremity an opening directed obliquely from above downward; this opening is generally situated three inches below the commencement of the intestine, and is formed by the mucous and cellular membranes of the latter and the ductus choledochus, which are uninterruptedly continuous with each other.

The lower part of this orifice does not belong to the ductus choledochus alone, but it is common to the pancreatic canal.

§ 2228. The most evident function of the liver is the very important one to secrete bile, a green, very bitter alkaline liquid, which is indispensably necessary to digestion; its physical qualities vary much in more than one respect. The bile is generally distinguished into *cystic* and *hepatic;* the first is thicker, darker, more bitter, and consequently more concentrated than the second; which differences depend on the gall-bladder, and not on the different origin of these two fluids, although Malpighi* and Galeati† have adopted this last opinion, or at least in part.

It is very probable, that putting out of view this difference of concentration, the bile has not always the same chemical composition.

It always contains a considerable quantity, and generally about eleven-twelfths of water. The rest is composed, according to Thenard, of albumen and of resin, of each about an equal quantity, which form almost the whole of it; a small quantity of insoluble yellow substance, of a still smaller quantity of soluble substance, finally, some traces of soda, of the phosphate, the sulphate, and the hydrochlorate of soda; of the phosphate of lime, and of the oxide of iron, all of which are dissolved in the water except the yellow substance, which is insoluble.‡ The resin admitted by Thenard and his successors, is produced, according to Berzelius,§ by the action of acids on a peculiar substance, similar to albumen. This chemist considers bile composed in 1000 parts: of water 907.4; of a peculiar substance 80.0; of mucus 3.00; of soda and common salts 9.6. None of these constituent parts contain azote; this is curious, on account of the frequent change of bile into a fatty body, and on account of the analogy of the meconium with vegetable substances.

Thenard asserts that picromel, a peculiar substance of a sweet and bitter taste, which commonly occurs in the bile of most mammalia, does not exist in that of man, but it has been found there by Chevalier.‖

Probably the bile is formed entirely, or in great part, at the expense of the venous blood of the vena-portæ, and the hepatic artery only serves to nourish the liver.

The principal arguments in favour of this opinion, are:

1st. The distribution of the hepatic artery in the vascular membranes.

2nd. The existence even of the system of the vena-portæ.

3rd. The great analogy between the venous blood and the bile, and between it and the arterial blood.

* *De liene,* c. vi.
† *Com. Bonon.,* vol. i.—ib. vol. ii. p. i.
‡ *Mém. de la soc. d'Arcueil,* vol. i.
§ *Med. chir. trans.,* vol. iii.
‖ *Annales de chimie et de physique,* vol. ix.

4th. The relation between the calibre of the hepatic vein and the size of the liver, without regard to the abundance of the biliary secretion, while this latter circumstance is always attended with a greater development of the vena-portæ.

The arguments adduced against this theory, are:—

1st. The absence of the system of the vena-portæ in the invertebral animals.

2nd. The cases where the vena-portæ opens into the vena-cava, and the hepatic artery is unusually large.

3rd. The correspondence between the calibre of the excretory duct of the liver and that of the hepatic artery, and the disproportion between that of the hepatic canal and that of the vena-portæ.

These arguments do not refute those on the other side. We have reasons for thinking that the arterial blood of the invertebral animals is perhaps more proper for the secretion of bile than that of the vertebrated animals. Possibly, also, the arterial blood of the latter was more appropriate for this use in the anomaly on which the second argument rests, than generally, because the biliary secretion then did not contribute to render the blood of the vena-portæ more analogous to that which circulates in the arteries. Farther, all the known cases of this anomaly have been observed in children, the bile being less bitter and less in quantity than usual. As to the third objection, the hepatic artery compared with the arteries of the other secretory organs, seems too small to admit that it serves for secretion and nutrition.

Some physiologists, regarding the size of the liver, its constant existence, and the frequency of its diseases, have been led to believe that it fulfils in the economy another function from that of secreting bile; but this other function is not proved. The uses of the bile are not confined to digestion, but it is connected with the whole vital action; in this respect, the secretion which forms it, prevents an excess of hydrogen and carbon in the body, as is indicated by its increase when the respiratory function diminishes in the animal series, when it does not exist as in the fœtus, or when it is deranged as in certain diseases.*

The purpose of the circulation of the vena-portæ, however, may also be to attenuate, to assimilate foreign substances brought by the venous system into the intestinal canal, and thus diminish the injurious influence they might exercise on the body.

C. DIFFERENCES DEPENDING ON DEVELOPMENT.

§ 2229. The differences depending on the development of the liver† relate to its volume, situation, form, and texture.

1st. The liver is very large during the first week of gestation, and we may say from the first moment of its appearance, that it is propor-

* Meckel, *Abhandlungen*, 1806.

† Walter, *loc. cit.*, sect. i.—A. Portal, *Observations sur la situation des viscères du bas-ventre chez les enfans, et sur le déplacement qu'ils éprouvent dans un âge plus*

tionally much larger the younger the fœtus is. Thus, in the fœtus of three weeks, its weight is one half that of the rest of the body,* and even in the full grown fœtus it is to the latter as 1 : 18, or as 1 : 20, while the relation is as 1 : 35-36 in the adult. But the great proportional size of the liver diminishes at the end of the first half of gestation, because, after this period, the gland increases more slowly. It, however, continues to grow till birth; but afterward the absolute weight and size diminish until the end of the first year, for we have found in five new born children, that the liver was one quarter heavier than in five other children from eight to ten months old.

2nd. The liver at first occupies a much greater space the younger the fœtus is; even at the third or fourth month of gestation, it nearly fills the cavity of the abdomen, descends to the crest of the ileum, and covers the other viscera. This difference, however, partly depends upon its being situated more perpendicularly at first, so that then, that face which is afterwards superior, looks forward, and that which is to be inferior, backward.

3rd. Its formation is at first as much more symmetrical as is its situation, and its left lobe differs less in size from the right lobe, and the limit between these two parts corresponds more to the median line. The absolute diminution mentioned above, takes place almost entirely at the expense of the left lobe, for while during this period, the right lobe preserves the size it had at birth, and often even increases a little, the left diminishes in every direction, so that in a child of a year old, it is hardly half as large as in a new born child; the lobe of Spigel, on the contrary, is more developed. The liver is at first more rounded, and its lower face is more convex than it is afterwards.

4th. Its tissue is softer, more homogeneous, more brittle, and more vascular in the earlier periods of life than subsequently, where the vessels diminish in size, and many of them disappear. We, however, very readily distinguish the two substances in the full grown fœtus.

5th. Its colour is at first a bright greyish brown; it does not become a deep red until after the first half of gestation; its tint brightens shortly after birth, and its tissue then changes also a little in appearance.

§ 2230. The gall-bladder is at first entirely concealed in the substance of the liver, is proportionally very long, narrow, filiform, a little enlarged at its lower extremity, and empty. Its cavity cannot be seen except by the aid of the microscope. Its inner membrane is smooth until the sixth month of gestation; broad, irregular elevations are then developed in it, between which are narrow depressions, similar to superficial grooves. These grooves gradually become deeper, and also more numerous, and many fissures are developed on

avance; in the *Mémoires de Paris*, 1771.—Id., *Observations sur la situation du foie dans l'etat naturel, avec des remarques sur la manière de connaitre, par le tact, plusieurs de ses maladies*; in the *Mém. de Paris*, 1773.—J. S. Schumann, *De hepatis in embryone magnitudinis causis ejusdemque functione cum in fœtu tum in homine nato*, Breslau, 1817.

* Walter, *loc. cit.*, p. 45.

he surface of the elevations; hence, regular and narrow cellules are ormed, which are separated by thin intermediate septa.

Notwithstanding its primitive narrowness, the gall-bladder is never leficient at any period, according to our observations, as one would e led to believe from some cases where its total absence has been sserted. Its situation also in regard to the other biliary organs, is lways the same; consequently it never arises by a kind of granulaion, developed from the extremity of the biliary passage, but it rises in the groove at the lower part of the liver, which is destined articularly for it, and which is at first proportionally much deeper han in the adult. We have never known it to communicate with he liver at first by one or more special canals, while we have seen it manifestly terminate in a cul-de-sac.

D. ABNORMAL STATE.

§ 2231. The liver is one of the organs most* frequently abnormal n more than one respect, but principally in its texture, which unoubtedly depends on the numerous organic elements which compose it.

A. LIVER.

§ 2232. The deficiency of the liver has hitherto been observed nly in some acephalous monsters; in these it is the rule, which has ut few exceptions, that the liver is always very small.

This organ sometimes preserves the same situation as in the fœtus, hich depends on the imperfect development of the anterior face of the bdomen. In this case it is sometimes situated externally, forming ither alone or with the other viscera, an umbilical hernia, in which it wholly or but partially contained. It exists more rarely in the cavity f the thorax, on account of the imperfect development of the diahragm. Sometimes, in these two cases, especially the first, the heriary part forms a prolongation, which is attached to the peduncle; is may give rise to the opinion that two livers exist. Sometimes, lso, when no similar mechanical cause exists, the liver is divided by ore or less deep grooves, into a greater or less number of distinct bes.

Sometimes an anomaly of the liver exists, similar to the latter in xternal appearance, but differing much from it in form and origin. consists in *fractures* of this organ, which are frequent on account f its fragility, even when the external parts are uninjured from

* Portal, *Observations sur la nature et le traitement des maladies de foie*, Paris, 13.—Farre, *The morbid anatomy of the liver*, London, 1812-1815.—J. Thomas, *A eatise on the diseases of the liver and digestive organs*, London, 1820.—J. Johnston, *treatise on derangement of the liver*, London, 1820.—J. Faithorn, *Facts and obrvations on liver complaints and bilious disorders in general*, Philadelphia, 1820.

external causes, acting not only on the region of the body in which it is situated, but also upon remote parts.

It is rare that the liver is abnormally small from a primitive deviation of formation, but it often diminishes in the course of time, particularly in advanced life, and finally becomes unusually hard and firm; this state is termed *scirrhus*, although this term is not perfectly convenient.

*Hypertrophy** of the liver is one of its most common affections; it supervenes at all periods of life, but most frequently in advanced age: it is generally attended with a greater or less alteration of texture, and particularly with *induration*, even when it does not depend solely on new formations within the gland.

Induration of the liver, however, is not always attended by its hypertrophy, although the contrary is generally admitted, since the latter is sometimes attended with softening. Hypertrophy of the liver frequently attends chronic general diseases, especially rachitis, scrofula, and dropsy. In this case the gland is usually harder than in health: but in scrofula, on the contrary, where we find hypertrophy at least as frequently, its tissue is softer than in the normal state. The enlargement of the liver, which usually attends pulmonary affections, is evidently, at least in most cases, an effort of nature to restore health.

Induration of the liver is the most frequent alteration of texture, and it often exists with or without enlargement. Softening of the liver is much more rare, and exists sometimes with, and sometimes without atrophy of the gland.†

The new formations in the liver are rarely repetitions of the normal tissues: the most common anomaly is the change into fat, which exists in several different degrees, usually affects the whole organ, and is observed in the idle and luxurious.

Accidental ossification is generally developed on the edge of the liver, below the peritoneal coat. Probably it is only a change of another accidental formation, for instance, of one of those serous or fibro-serous cysts, often developed in the liver, where they form hydatids.

The liver is not unfrequently the seat of entirely new formations, generally termed *tubercles* (*tubera*).‡ These tumours are rarely enclosed in a cyst, and are rounded. They are generally whitish, seldom red or brown. They vary in size from three to four inches. They are frequently very numerous, being developed in the centre of the liver, which is otherwise healthy. Like most new formations, they are

* V. Murat, *Sur l'hypertrophie du foie*; in the *Bull. de la soc. méd. d'emul.*, September, 1821.

† Portal, p. 117.

‡ V. Murat, *Des moyens de distinguer entre elles les diverses affections du foie, désignées sous les noms de tubercules scrofuleux, d'hydatides, de squirrhe, d'hydropisie enkystée, généralement confondues sous le nom d'obstructions*; in the *Bull. de la soc. méd. d'emul.*, September, 1821.

generally albuminous.* Those, however, which have a brownish tint, appear from some recent experiments to be more analogous with gelatine.† The diseases they resemble are principally scrofula or fungous hæmatodes.

All the anomalies in the mass, size, and consistence of the liver hitherto mentioned, all the accidental formations mentioned in this gland, supervene principally after the immoderate use of ardent spirits. As they render the liver unfit for the secretion of bile, or prevent the excretion of that which it forms, they frequently occasion *jaundice.* This affection depends on a deposition of bile in a greater or less number of organs and fluids, particularly in the skin. It may also be determined by the adjacent organs, and sometimes we discover no alteration to which it can be attributed.

From the important functions of the liver, and also the intimate connection between it and the mind, this organ varies more or less in all general chronic and in all mental affections.

Entozoaries are developed in this gland more rarely. The animals most commonly found there are hydatids, which occur in the liver more frequently than in any other organ; they are extraordinarily large and numerous, and form very rapidly; they are generally developed in one point, rarely in several, and most commonly in the right lobe. They are commonly separated from the healthy substance of the organ by cysts, usually formed by several layers. They not unfrequently destroy the liver to a great extent, and quitting the place where they are formed, generally proceed outward, most commonly by entering into the intestinal canal, more rarely into the chest and lungs, sometimes even directly through an opening in the common integuments.

Biliary concretions are more rare in the liver; probably they always form in the biliary passages, whence they afterwards pass into the substance of the gland.

B. BILIARY PASSAGES.

§ 2233. Sometimes, but rarely, a part of the biliary passages, particularly the gall-bladder, is deficient‡ from a primitive deviation of formation, although this anomaly does not necessarily exercise an injurious influence on the health, which is less astonishing, since, according to the experiments of Herlin, the gall-bladder may be extirpated in cats without inconvenience, and it is normally absent in many animals. On the contrary, the entire absence of the biliary passages§ is always attended with the most fatal results.

* Portal, p. 95, *Des obstructions albumineuses du foie.*
† Portal, p. 98, *Des obstructions gélatineuses du foie.*
‡ Ollivier, *Note sur l'atrophie de la vésicule biliare*; in the *Archiv. gén. de méd.*, vol. v., p. 196.
§ Home, *Phil. trans.*, 1813, pt, ii., p. 146-158.

We rarely also meet in the biliary passages deviations of formation in regard to the quality, such as the existence of *hepato-cystic ducts* (*d. hepato-cystici*), going directly from the lower face of the liver into the gall-bladder, the slow union of the two roots of the hepatic canal, the opening of one or more branches into the cystic canal, or even into the gall-bladder, the insertion of the ductus choledochus in a point different from the intestinal canal, or even in the stomach.

Of all the biliary passages, the gall-bladder most frequently presents anomalies of this kind, since when it is divided by a contraction into two cavities, placed successively in a longitudinal direction, or, as is more rare, when a longitudinal septum divides it into two parts adapted one to the other. The enlargement and the contraction of the biliary passages generally depends on mechanical causes, among which we must place first the biliary calculi contained within them, next, as is more rare, the engorgement of the lymphatic glands, which compress it from without inward.* The gall-bladder may be contracted or dilated by the calculi within it. The contraction and the total obliteration of its cavity occur when a few or small calculi prevent by their situation the bile from entering it. On the contrary, numerous or large calculi, either alone or together with the bile, often dilate the gall-bladder considerably when they are so situated as not to prevent entirely the entrance or departure of the bile, or when they exist in the ductus choledochus. Sometimes the gall-bladder is enormously distended, simply by an increased secretion of bile, without any mechanical obstruction; the membranes of this latter are then generally thin, while in the opposite state they are very thick. Sometimes the calculi are separated by perfect septa.

New formations rarely occur in the gall-bladder; we must mention as such, however, the osseous plates sometimes developed on the outer face of the mucous membrane, and the hairs inserted on its inner face.

* Andral (*Observations sur l'oblitération des canaux biliaires*; in the *Archiv. gen. de méd.*, vol. vi., p. 16) admits four principal causes of perfect or imperfect, transient or permanent obliteration of the biliary passages; these are the obstruction of their cavity by a foreign body, a compression upon their parietes by membranous folds and by tumours of different kinds, a spasmodic contraction independent of all inflammation, and an inflammation followed by the engorgement of the mucous membrane and its thickening. He remarks that the first two causes are frequent, that in most cases the third has rather been supposed than demonstrated, and that physicians have not yet attended to the fourth. The latter, however, seems to be, if not always, at least very frequently, a consequent of a gastro-intestinal inflammation; it is not unusual, and we have every reason to think that it always exists in the cases where the *nervous* pathology led one to suppose the third. Like all inflammations, that of the biliary passages, whether acute or chronic, is attended with the thickening of the parietes of the canal, which is finally changed into a ligamentous cord. F. T.

C. BILE.

§ 2231. The bile is often abnormal in its physical and chemical qualities, although we cannot always discover a certain connection between its anamolies and the state of the liver. It however seems less bitter when this organ is changed into fat.

The most striking anomaly is that resulting from the presence of biliary calculi.*

These concretions, which are found in aged persons, or in those who lead a sedentary life, differ from each other in situation, composition, colour, number, size, texture, form, and consistence.

1st. *Situation.*—The biliary calculi generally occur in the gall-bladder, so that they seem to be developed in this organ. They have been found also in the biliary passages, in the substance of the liver, although proportionally very rarely. Sometimes also they are situated in the hepatic or cystic canal, or in the ductus choledochus, but they finally fall into the gall-bladder. Not unfrequently they leave the ductus choledochus and pass into the intestinal canal.

The rarest case is where they occur out of the cavity of the biliary passages in the substance of the liver, or in the membranes of the gall-bladder. The former may be formed in the place where they occur; but the second are doubtless primitively developed in the cavity of the gall-bladder, and afterwards glide between its membranes, and are then inclosed by the closing of the opening which at first existed, although it is admitted they are formed in the place even where hey are observed; and this fact has even been cited to prove that the bile is partially secreted by the glands of the gall-bladder.†

The justice of our etiology is demonstrated by the fact, that calculi are sometimes found in the depressions of the gall-bladder, which case is evidently intermediate between that where they are entirely loose in the cavity, and where they are situated on the outside of it and encircled in the membranes.

2nd. *Chemical composition.* The chemical composition of the biliary calculi generally causes all those properties of which we have yet to speak. They are composed principally of two different substances; one more or less dark in colour and brownish, and the other white; the latter is termed *cholesterine.* The bile contains none of it in the ormal state.‡ The other is the yellow colouring substance of this

* Vicq. d'Azyr, in the *Mém. de la soc. de méd.*, 1779.—Fourcroy, *Sur les calculs des animaux*: in the *Annales du Muséum*,, vol. i.—S. T. Sœmmerring, *De concrementis biliariis*, Frankfort, 1793.—Mosovius, *Diss. de calculorum animalium origine et naturâ*, Berlin, 1812.

† D. G. Galeati, *De calculis in cysti felleâ et intra ejus tunicas repertis*; in the *Comm. Bonon.*, vol. i., p. 354.—Id., *De cystis felleæ ductibus*, same journal, vol. i. pt. ii. p. 331.

‡ Chevreul has detected it in the bile of man and several animals (*Note sur la présence de la cholestérine dans la bile de l'homme*; in the *Journ. de physiol. expér.*, vol. iv., p. 267). F. T.

fluid. The cholesterine probably arises from the change of a peculiar substance which exists in the bile.

The biliary calculi also contain a little of bile, which is easily separated from it by water.

We rarely find carbonate of lime on their surface.*

3rd. *Colour.* These concretions are more or less coloured from the brightest yellow to the deepest dark brown, because they generally contain the substances mentioned above. Those only which are formed of cholesterine are entirely white, and they are very uncommon. Farther, the tint varies in the different parts of a biliary calculus.

4th. *Number.* It varies from one to several hundreds. The calculi formed of pure cholesterine are usually single, or at least very few.

5th. *Volume.* It varies no less than the number, and usually in an inverse ratio. The calculi of pure cholesterine are generally larger than the compound concretions. Not unfrequently one of them fills the gall-bladder, and even distends it.

6th. *Form.* The biliary calculi are generally more or less round, those of pure cholesterine are more oblong. Their form is modified also by their number, since the friction between them renders their surface smooth. Hence why those of cholesterine are generally more corrugated than the others; but these concretions rarely present sharp points.

7th. Their *texture* varies.

a. The biliary calculi are generally full and solid; we, however, have one which is hollow.

b. They are formed of several superimposed and differently coloured layers.

c. These layers are sometimes, though rarely, composed of one of the two substances mentioned above. In the contrary case they are all coloured, and differ only in their shade of colour. We not unfrequently find externally an entirely white layer.

d. The light coloured layers have generally more or less evidently a radiated and fibrous texture. It is often easy to see that they are formed of very oblong pyramids slightly connected with each other, the summits of which converge towards the centre. This form seems to depend on the cholesterine, for it is never more apparent than in the calculi formed by this fatty body, and it decreases inversely with the colour.

e. *Consistence.* Biliary calculi generally are neither very hard nor solid. They are much softer and more brittle than the urinary concretions. Sometimes, however, they are considerably hard. Those of pure cholesterine are generally harder than the others, being even very firm and solid; but they are frequently also very soft, while others which are more deeply coloured are considerably hard.

* *London med. repository,* vol. iv., p. 469.

II. PANCREAS.

2235. The *pancreas** is the largest of the salivary glands. Its weight and size are three or four times those of the parotid gland, as it is six inches long and one thick, and weighs from four to six ounces. It is oblong, and is situated transversely at the upper part of the abdominal cavity, before its posterior wall, in front of the first and second dorsal vertebra, behind the stomach. Its left extremity generally touches the spleen and the left kidney. It passes before the aorta, and its right extremity is situated between the upper and lower folds of the duodenum.

It is included between the two layers of the transverse mesocolon, which slightly adheres to its upper part, and does not cover it posteriorly.

Its figure is that of a hammer, since it enlarges at its right extremity, from whence proceeds an inferior prolongation, which embraces the duodenum posteriorly, and on the left, and even a little forward. The lower prolongation is called the *head*, and the transverse larger portion the *tail*.

§ 2236. The pancreas is attached to the adjacent parts by a very loose cellular tissue, and enveloped by a thick layer of the same; it has no special capsule. We also distinguish through the cellular envelope, the lobes which unite to form it.

These lobes can be divided into extremely minute lobules, attached by a very loose cellular tissue.

The pancreas is yellowish brown, and rather firm in its texture.

§ 2237. A considerable excretory duct passes entirely through this organ; it is white and solid, and is called the *pancreatic canal* (*ductus pancreaticus*),† or the *canal of Wirsung* (*ductus Wirsungianus*), This canal arises at its posterior extremity by the union of several branches, which anastomose at an acute angle. In its course it receives at a right angle, both above and below, a considerable number of other branches, which may be easily followed by smaller granulations, so that it gradually increases in volume, and finally becomes a line and a half in diameter. Just before quitting the gland, it also receives one or more very large twigs, which arise from the head, and which also open separately into the duodenum.

This canal is not visible on the surface of the gland, which must be cut across in order to see it.

* Brunner, *Exp. nova circa pancreas*, Amsterdam, 1638.—Graaf, *De succo pancreatico*, Leyden, 1664.—Johrenius, *De affect. hypochondriacis*, Rinteln, 1678.—J. M. Hoffmann, *De pancreate*, Altdorf, 1706.—J. D. Santorini, *Tabulæ septemdecim*, tab. xiii.

† J. G. Wirsung, *Figura ductus cujusdam, cum multiplicibus suis ramulis noviter in pancreate, in diversis corporibus humanis observati*, Padua, 1643.

It generally opens into the duodenum, three or four inches below the pylorus, but sometimes much lower down, and even ten inches from it.

In the place where it communicates with the duodenum, it unites externally with the ductus choledochus, but the two cavities remain perfectly distinct, even when proceeding side by side through the membranes of the intestine. They open side by side near the pancreatic duct, a little to the left of the choledochus, at the base of a small cavity about two lines long, the membrane of which has all the characters of the inner tunic of the duodenum, so that we cannot properly consider them as having a common orifice.

Near its orifice the excretory duct of the pancreas enlarges more or less, but contracts at its opening, although there is no fold similar to a valve in this or in any other part. The appearance of a valve at its opening depends only on the septum between it and that of the ductus choledocus.

§ 2238. The pancreas, like all the salivary glands, and most of the glandular organs, is more developed in the early periods of life than subsequently.

We have observed that its excretory duct very constantly presents a remarkable difference, as it is at first double, that is, beside the permanent valve, there is then a second, which opens separately into the duodenum.*

§ 2239. The congenital anomalies of this gland extend principally to the arrangement of its excretory duct, which sometimes seems double ; this state must be considered as a permanence of that in the fœtus.†

The most remarkable consecutive anomalies are *induration* and *hypertrophy*. We more rarely find in its excretory duct, calculi,‡ composed of phosphate of lime and of an animal substance.

III. SPLEEN.

A. PERFECT STATE.

§ 2240. The *spleen* (*splen*, *lien*)§ is situated in the left hypochondrium, between the great cul-de-sac of the stomach, the lumbar portion

* Meckel, *Abhandlungen*, p. 331, 353, 366, 380.

† Tiedemann, *Sur les différences que le canal excreteur du pancreas presente dans l'homme et dans les mammifères* ; in the *Journ. compl. des sc.méd.* vol. iv. p. 370.

‡ Baillie has figured a remarkable case of it. (*Engravings*, fasc. v. tab. vii.)

§ F. Schuyl, *De naturâ et usu lienis*, Leyden, 1664.—Malpighi, *De liene* ; in *De structura viscerum.*—C. Drelincourt, *De lienosis*, Leyden, 1693.—G. Stukeley, *The spleen, its description, uses, and diseases*, London, 1723.—J. G. Duvernoi, *De liene*; in the *Com. Petrop.*, vol. vi. p. 156.—S. T. Quellmalz, *De liene*, Leipsic, 1748.—C. L. Rolof, *De fabricâ et functione lienis*, Frankfort, 1750.—Lassone, *Histoire anatomique de la rate* ; in the *Mém. de Paris*, 1754.—Werlhof, *De splenis usu*, Wolfenbuttel, 1761.—J. F. Lobstein, *De liene*, Strasburg, 1774.—J. P. P. Assolant, *Re-*

of the diaphragm, the commencement of the descending colon, and the left renal capsule, which it covers anteriorly. Its form is elliptical; its posterior or external face is convex; the anterior or internal is concave, and divided by a longitudinal groove called the *fissure of the spleen* (*hylus lienalis*), into two halves, an anterior, which is the larger, and a posterior. Its upper extremity is a little thicker than the lower; a fold of the peritoneum unites it to the diaphragm, the stomach, and the descending colon.

It varies much in size, not only in different individuals, but also in the same individual at different periods, and inconstantly. In general we may say, that in the adult it is about four inches long, three broad, and a little less than one thick.

Its weight varies as much as its size. Its mean weight is eight ounces, so that in the adult it is to that of the whole body as 1 : 210. But the volume and the weight of this organ are not necessarily in an inverse ratio with the distention of the stomach, as has been asserted.* Its specific gravity, compared with that of distilled water, is as 1.200 : 1000.

It is a brighter or darker red.

The consistence of the spleen is slight; it is also very soft.

§ 2241. At first view the spleen seems formed entirely of blood-vessels, of which the arteries come from the cœliac trunk and the veins rest directly on the surface of the artery, and are proportionally larger than in any other part of the body; they empty into the vena portæ, and carry there a very dark blood. The substance of the organ is surrounded by a very firm sero-fibrous membrane. The external layer is serous and comes from the peritoneum, with which it is continuous by two prolongations mentioned above.

The fibrous layer belongs properly to the spleen, but it can be separated from the serous membrane only to a slight extent in the fissure.

Numerous layers and very minute solid fibres proceed from it, which interlace in many different ways, and enter the space circumscribed by the capsule, leaving between them irregular spsces, in which the splenic vessels are distributed.

These productions form, properly speaking, the base of the tissue of the spleen.

Beside these fibres, other hollow canals proceed from the inner membrane of the spleen to its fissure; these closely envelope the vessels and unite with them. The first filaments are attached to the outer

cherches sur la rate, Paris, 1801.—A. Moreschi, *Sul vero e primario usu della milza*, Milan, 1803.—E. Home, *On the structure and use of the spleen*; in the *Phil trans.*, 1808.—C. F. Heusinger, *Ueber den Bau und Verrichtung der Milz*, Thionville, 1817.—F. Gelihaus, *Inaugural Abhandlung über den Nutzent der Milz*, Wurzburg, 1817.—G. M. Felici, *Osservazioni fisiologiche sopra le funzioni della milza*, Milan, 1818.—I. Dœllinger, *Betrachtungen uber die Milz*; in the *Deutsches Archiv. fur die Physiologie*, vol. vi. p. 155.—Jæckel, *Etwas uber die Verrichtung der Milz*; same journal, vol. vi. p. 581.—Hodgkin, *Sur les fonctions de la rate*; in the *Journ. compl. des sc. méd.*, vol. xiv., p. 89.—Home in the *Phil. trans.*, 1821, p. 25.

* Assolant, *loc. cit.*, p. 129-133.

face of these canals in the same manner as to the inner face of the fibrous capsule.

The splenic arteries give off in their course numerous branches, which divide into very minute ramusculcs, arranged like the bristles of a brush, but they do not anastomose together. On the contrary, the veins which surround these arterial fasciculi, frequently anastomose with each other, and with the adjacent veins. There are, however, no great communications between the arteries or the veins of the different regions of the spleen. Those between the veins and arteries are very large, as may easily be seen by the aid of a microscope, or by the facility with which injections pass from the arteries into the veins.

Besides the blood-vessels, the spleen also possesses numerous lymphatics. Its nerves come from the splenic plexus, and are very small. They are scarcely one-twelfth as large as the arteries they surround, and we cannot trace them far within the organ. Beside these constituent parts, which several anatomists assert are the only ones, the spleen also contains, according to the more correct observations of others, particularly Malpighi, Hewson, Dupuytren, Home, Heusinger, and Meckel, very many rounded, whitish, and very probably hollow, or at least very soft corpuscles, which differ much in respect to size and situation; their size varies from one-sixth of a line to one line, and they are sometimes near, and sometimes rather distant apart.

These corpuscles are very intimately connected with the rest of the tissue of the spleen, and receive many blood-vessels; according to Home's observations, confirmed by those of Heusinger and our own, they swell much in animals when they drink.

Malpighi considers them as glands. Ruysch and several other anatomists have denied their existence, and have asserted, but wrongly, that they are only simple fasciculi of vessels.

Although neither these corpuscles, nor the spleen, have excretory ducts, they very probably contribute much to the changes of the blood in passing through this organ, and assist in forming the gastric juice, but particularly the bile.

The substance of a reddish brown, easily separated by washing and pressure, should be regarded not as a constituent part of the spleen, but as the blood changed by this organ.

The cellules heretofore admitted in the spleen, were very probably produced by the destruction of a part of the vessels, and of the internal fibrous tissue, by injections made with too much force, whence were formed spaces which are afterwards distended by inflation.

§ 2242. As the spleen has no excretory duct, its functions are very obscure, and the more so, as it has frequently been extirpated without producing any constant or very great derangement in any function. Even at present, after so many experiments infinitely varied, after so many observations and reflections, we can only hazard conjectures on this subject. We may, however, conclude from facts hitherto

known, that the spleen is intimately connected with the functions of the liver and stomach, and acts in concert with these two organs.

That it assists in the functions of the liver, is proved by the fact, that all the blood which passes through its tissue, is carried to this organ by the trunk of the vena-portæ. Hence, we may conjecture, and very probably, that the blood is changed within it, and rendered more proper for the secretion of bile, which conjecture is not contradicted by chemical experiments, from whence it has been concluded, that the blood of the splenic veins does not differ from that in the other veins. Possibly, also, the spleen contributes mechanically to increase the secretion of bile, since, during abstinence, a greater or less quantity of blood collects there, which is afterwards expelled by the pressure of the stomach when filled with food, and then goes toward the liver. But as the blood is not merely circulated in the spleen, but there undergoes some change, it follows, that the relation is not mechanical only, but also chemical.

The spleen receives less blood at the commencement of digestion, because the stomach, which is then full, prevents the blood from flowing freely into it; but in proportion as the contents of the stomach pass out from it, the blood flows more easily to the spleen, and the function of this latter, in regard to the liver, becomes more active. Probably also the spleen concurs in the accessory function attributed above to the liver, that of neutralizing and assimilating foreign substances introduced into the body. Hence we must consider it as a viscus which performs, in regard to the vascular system, particularly to the liver, the same part as the conglobate glands towards the lymphatic system. It is more analogous to these glands than to the liver, as it has no excretory duct. The liver then appears as an organ composed of a conglomerate and a conglobate gland in the vascular system.

The action of the spleen may also relate to that of the stomach in several different respects :—

1st. In a dynamical respect, since the two organs seem to be opposed to each other, and the soft and blackish spleen may be considered, from its substance and the change of the blood which passes through it, as contributing particularly to produce hydrogen, while the stomach is an organ which, from the nature of its secreted fluid, tends particularly to produce oxygen.

2nd. In a mechanical respect, as the spleen attracts the blood to it when digestion is not going on, while it receives less when this viscus is full, so that the blood flows in greater quantity toward the latter, that is, precisely at the period when most necessary to the secretion of the gastric juice.

The function of the spleen seems also to be to receive promptly at least a part of the liquids introduced into the stomach, although this function does not belong exclusively to it, since after it has been extirpated the liquids disappear as quickly as before, and the substances contained in this viscus reappear in certain fluids.

B. DIFFERENCES DEPENDING ON DEVELOPMENT.

§ 2243. At first the spleen does not exist. It begins to appear distinctly during the second month of gestation.

It is at first infinitely smaller in proportion to the body, and particularly to the liver, than it is subsequently, although it wrinkles and also wastes in old age.

The whitish corpuscles are proportionally larger and more visible during the latter periods of fœtal existence and in infancy than during the successive periods.

All these peculiarities are very important, as they support the eighth law established in our introduction. In fact the spleen does not exist in the mollusca which have a liver; it becomes proportionally smaller and smaller as we descend from the mammalia toward the lower classes of the animal kingdom; and in most mammalia, as also in several other animals, the corpuscles are regularly larger in proportion than in man.

C. ABNORMAL STATE.

§ 2244. Among the anomalies of the spleen we must distinguish particularly some deviations of formation*, which deserve to be noticed.

This organ is very rarely deficient from a primitive deviation of formation in a subject where the formation is otherwise normal, while it is generally absent in cases of acephalia vera.

A deviation of formation almost peculiar to the spleen, or at least observed in it more frequently than in any other organ, is its division into several spleens termed *accessory* (*lienculi*, s. *lienes accessorii*). These accessory bodies are always situated on the inner face, and generally toward the lower extremity of the spleen.

They are usually, but not always, rounded, and vary in number from one to twenty-three. The latter number, however, has been observed only once, and we rarely find more than one supernumerary spleen.

The great number of these accessory spleens is usually attended with other deviations of formation. This occurred in a subject who had twenty-three†. In another case, where there where seven, all the organs of vegetative life were at the same time inverted‡. In a

* C. S. Heusinger, *Mémoire sur les monstruosités de la rate produites par le défaut de développement de ce viscère*; in the *Journ. compl. des sc. méd.*, vol. x., p. 216.

† Otto, *Handbuch der pathologischen Anatomie*, p. 302.

‡ Heusinger, *loc. cit.*, p. 62.

hird, where there were four, the foramen ovale of the heart was open o some extent.*

The accessory spleens vary much in size.

The existence of a great number of fissures which are frequently ery deep on the anterior edge of the spleen, particularly toward its ower extremity, or of a more or less distinct transverse fissure, which asses over its whole external face, form a remarkable intermediate legree between this anomaly and the normal state.

Among the accidental deviations of formation, one consists in n enlargement of the spleen, usually attended with induration, which ommonly arises from the metastasis of a general disease†.

We not unfrequently find the spleen unusually hard without nlargement or very soft. The latter exists particularly in diseases ttended with great debility.

New formations are rarely developed in the spleen. The tubercles ometimes seen in it are probably white corpuscles somewhat nlarged. Perhaps we should consider a special formation a solid neven yellowish white mass which is frequently developed in he spleen. It, however, seems to be very similar to fungus hæmaodes.

The capsule of the speen frequently ossifies, particularly in dvanced age, to such an extent even that when the osseous ubstance has acquired a certain thickness in proportion to which the rgan always wastes, we are led to think that the spleen itself s changed into bone.

ARTICLE FIFTH.

ESSELS AND NERVES OF THE ABDOMINAL PORTION OF THE DIGESTIVE ORGANS.

§ 2245. The vessels of the most important and the largest part of he digestive organs mostly arise from three trunks, the cœliac, and he superior and inferior mesenteric arteries, which come directly rom the abdominal aorta, and anastomose very frequently together. he lower extremity of the rectum also receives some branches from he hypogastric artery.

The veins, if we except those of the lower part of the rectum vhich empty into the iliac veins, unite and form the vena-portæ, so hat all the blood that returns from these organs passes through he liver before going to the heart, and from thence into the lungs.

* Baillie, *Phil. trans.*, vol. lxxviii, p. 350.

† C. F. Heusinger, *Ueber die Entzündung und Vergrosserung der Milz*, Eisenach, 1820.—S. Grottanelli, *Ad acutæ et ceronicæ splenitidis historiam nimadversiones*, Florence, 1821.—C. H. Schmid, *Commentatio de pathologiâ ienis*, Gottingen, 1816.

The nerves come principally from the great sympathetic nerve. Those of the stomach, however, arise chiefly from the pneumo-gastric nerve, and those of the rectum from the sacral pairs.

CHAPTER II.

ORGANS OF VOICE AND RESPIRATION.

§ 2246. In the preceding chapter on the systems we described the digestive organs which belong to vegetative life; these appear earliest in animals, or in the fœtuses of animals perform at first the functions of all the rest, and are the type on which these latter are formed, which are, however, less perfect and much less complex. We now proceed to describe the respiratory organs, in which the nutritious fluid formed in the first is in general perfected.

The vocal apparatus is so connected with the organs of respiration that it occupies the summit of the canal by which these latter communicate with the air by the cavities of the nose and mouth, and it is in fact only a development of the upper extremity of this canal. It is then most convenient to begin with it.

ARTICLE FIRST.

ORGANS OF VOICE.

§ 2247. The *organs of voice** are composed principally of the larynx, in which the voice is formed, although it is modified in different modes when passing through the cavities of the nose and mouth, which are situated before it.

I. LARYNX GENERALLY IN THE PERFECT STATE.

§ 2248. The *larynx* is an oblong, quadrangular cavity, formed of several cartilages, of ligaments which unite them, of muscles which

* Galen, *Vocalium instrumentorum dissectio:* in the *Opp. omn.*—Fabricius of Aquapendente, *De visione, voce, et auditu:* Id., *De larynge vocis instrumento:* in the *Opp. omn.*—J. Casserio, *De vocis auditusque organis.* Ferrare, 1600.—D. Santorini, *De larynge:* in the *Obs. anat.*, c. vi.—A F. Walther, *De larynge et voce,* Leipsic, 1740.—R. A. Vogel, *De larynge humano et vocis formatione,* Erfurt, 1747.—J. G. Runge, *De voce ejusque organis.* Leyden, 1753.—Herissant, *Recherches sur les organes de la voix des quadrupèdes et de celle des oiseaux:* in the *Mém de Paris,* 1753.—J. M. Busch. *De mechanismo organi vocis hujusque functione,* Groningen, 1770.—Vicq-d'Azyr, *De la structure des organes qui servent à la formation de la voix, considérée dans l'homme et dans les différentes classes d'animaux:* in the *Mém. de Paris,* 1779, p. 178-2 6.—J. Wolff, *Diss. de organo vocis mammalium,* Berlin, 1812

move them, and of a mucous membrane which covers them in every part, after which it is continuous upward with the buccal membrane, below with that of the trachea. This cavity gradually contracts a little from above downward. It is situated at the upper and anterior part of the neck, below and behind the lower jaw, between the trachea and the cavities of the nose and mouth, of which it is the direct continuation.

A. CARTILAGES OF THE LARYNX.

§ 2249. There are nine cartilages which form the base of the larynx, three of which are unmated and six exist in pairs. The pairs are situated on the sides; the unmated are divided by the medial line into two equal halves, a right and a left.

The unmated cartilages are the largest, and principally form the whole larynx. They are the *thyroid* and *cricoid* cartilages, and the *epiglottis*. The pairs are the *arytenoid*, the *rounded*, or the *tubercles of Santorini*, and the *cuneiform* cartilages.

I. THYROID CARTILAGE.

§ 2250. The *thyroid* cartilage (*C. thyroidea*), the largest of the cartilages of the larynx, forms its upper and anterior part produces at the upper part of the neck, a prominence called *Adam's apple*. It is an oblong quadrilateral plate, more broad than high and composed of two lateral halves, which unite forward on the median line, where the angle they form is more acute in the male than in the female. Hence this layer is very convex forward and very concave backward, where it is open.

Its upper edge is very convex; it however presents in its centre a deep groove, so that the cartilage is lower in this place.

Its lower edge is very convex: it is formed on each side of two superficial grooves, separated by a median prominence.

The posterior edges are loose; they extend upward and downward into two elongated horns, which are rounded and turned backward, and which are distinguished into upper and lower. The upper horns are longer and thinner than the lower.

We observe on the outer face of the cartilage at the base of the upper horn a considerable triangular prominence, whence arises an oblique line which descends from behind forward to the lower edge, and which separates the posterior sixth of each half of this external face of the five anterior sixths.

II. CRICOID CARTILAGES.

§ 2251. The *cricoid* cartilage (*C. cricoidea*, s. *annularis*), which forms the lower part and a portion of the posterior part of the larynx, is circular, as its name indicates, and about three times higher posteriorly than anteriorly. It is convex forward, and on the sides are depressions which render the surface corrugated, and on its upper edge is a sharp prominence which inclines outward.

The posterior part is irregularly quadrilateral and broader below than above. Its anterior face is uniformly concave; the posterior is loose and very prominent in the centre, especially below.

We there observe a depression on each side, and it presents a plane articular facet where it unites with the side.

Its upper edge also enlarges on each side into a plane articular facet which is inclined from above downward.

III. ARYTENOID CARTILAGES.

§ 2252. The *arytenoid, triangular,* or *pyramidal* cartilages (*C. arytænoideæ*, s. *triquetræ*, s. *pyramidales*) have an elongated triangular form. Their anterior face is convex and uneven, and divided by a transverse prominence into a superior and an inferior depression.

The posterior has about the same extent as the anterior, and is concave. The internal is much smaller than the other two, and is slightly convex.

These two cartilages are fitted by their concave base to the sides of the upper articular facets of the cricoid (§ 2251).

IV. ROUND CARTILAGES.

§ 2253. On the summit of each arytenoid cartilage is a much smaller, and also triangular cartilage, termed the *tubercle of Santorini*, or the *round or horny* cartilage, (*corniculum*, s. *capitulum Santorinianum*),* the convex face of which looks forward, and the internal backward. Its lower face is concave, rests on the convex summit of the preceding, and is articulated with it by a loose capsular ligament, some fibrous ligaments of which add to its solidity.

V. CUNEIFORM CARTILAGES.

§ 2254. The *cuneiform* cartilages (*C. cuneiformes*) are slightly curved on themselves. Their bases are turned upward, and their summits downward. They are situated in the centre of the membranous expansion extended between the arytenoid cartilages and the epiglottis.

* *Loc. cit.*, p. 97.

VI. EPIGLOTTIS.

§ 2255. The *epiglottis* (*epiglottis*, s. *ligula*), a very soft cartilage, is nearly rhomboidal; its lower part is pointed, and terminates by a superficial groove, and is situated directly above the groove of the upper edge of the thyroid cartilage. Its length exceeds its breadth, and it is much thinner from before backward than in any other direction, except at its centre. It presents numerous openings, through which penetrate small muciparous glands, which open on these two faces. Its elasticity, and the ligaments to be described, cause it generally to lie perpendicular, and to rise towards the isthmus of the fauces: but the weight of the substances which pass on it, and the action of special muscles, depress it, so that it covers the entrance of the larynx.

The epiglottis prevents the entrance of foreign bodies, especially the food and drink, from the cavity of the nose, and particularly the mouth, into the larynx. Although pathological observations, in regard to the absence of this cartilage,* and experiments, where deglutition has not been impeded by removing the epiglottis, when the nerves and muscles of the glottis were preserved, while it was very difficult when these nerves were divided, the epiglottis remaining entire;† although these facts‡ prove that the closing of the glottis also partially contributes to prevent the food from falling into the larynx, it does not follow that the epiglottis does not fulfil the function attributed to it by every physiologist since the time of Aristotle. This function, in regard to which we quote a lively, but perfectly correct remark of Casserio,§ has been doubted by Magendie, whose opinion has been contested by Mayer, from observations carefully made upon himself.‖

* Targioni Tozzetti, *Prima raccolta di osservazioni*, Florence, 1752.—Magendie, *Précis de physiologie*, vol. ii. p. 63.

† Magendie, *Mémoire sur l'usage de l'épiglotte dans la déglutition*, Paris, 1813.

‡ C. T. F. Reichel (*Diss. de usu epiglottidis*, Berlin, 1816) has observed contrary to Magendie's assertion, that removing the epiglottis always rendered deglutition difficult in those animals where it was removed. On this subject, Rudolphi mentions the case of a man who died of laryngeal phthisis, in whom the epiglottis was destroyed so that but a small portion of its base remained. This man found it very difficult to swallow: he was obliged to mix drinks with his food to form a kind of pulp, which was introduced into the stomach with difficulty. G. Sachse relates several cases, which prove that deglutition is always very much impeded in laryngeal phthisis. (*Beiträge zur genauern Kenntniss und Unterscheidung der Kehlkopfs-und Luftröhrenschwindsuchten*, Hanover, 1821). Farther, Rudolphi attributes to the epiglottis another use also: he thinks that this cartilage serves also in those animals who breathe through the nostrils, the mouth being closed, to favour the entrance of the air into the larynx, by presenting a more direct way than through the cavity of the mouth. F. T.

§ Loc. cit., *De epiglottide*, c. xvii., *Talis structura, tale officium, ut stupidus ille, vecorsque dici mereatur, quem non eorum consideratio, attonitum quasi, in admirationem Dei rapiat.*

‖ *Ueber die Function des Kehldeckels*, in the *Salzburger Zeitung*, 1814, vol. iii. p. 156.

B. LIGAMENTS OF THE LARYNX.

§ 2256. The cartilages of the larynx are united with each other, and with the hyoid bone and trachea, by capsules, fibrous ligaments, and compact cellular tissue.

I. SPECIAL LIGAMENTS.

A. BETWEEN THE THYROID AND CRICOID CARTILAGES.

§ 2257. The thyroid and cricoid cartilages are united by three ligaments, a central or pyramidal, and two lateral.

a. Middle crico-thyroid ligament.

§ 2258. The *middle crico-thyroid* or *pyramidal* ligament (*L. conoideum*, s. *thyreo-cricoideum medium*), is short, fibrous, strong, and triangular. Its base looks downward, and its blunt summit upward. It fills the space between the centre of the lower edge of the thyroid cartilage, and that of the upper edge of the cricoid cartilage.

It prevents the cricoid and thyroid cartilages from separating from each other too far upward and downward.

b. Lateral thyro-cricoid ligament.

§ 2259. The *lateral thyro-cricoid* ligament (*L. thyreo-cricoideum laterale*) is loose, composed of fibres, which are oblique from above downward, and situated between the lower horn of the thyroid cartilage and the lower articular facet of the cricoid.

Its uses are the same as those of the preceding. It serves, however, also to confine the motions of the two cartilages forward and backward.

B. LIGAMENTS BETWEEN THE THYROID CARTILAGES AND HYOID BONE.

a. Middle thyro-hyoid ligament.

§ 2260. The *middle thyro-hyoid* ligament (*L. thyreo-hyoideum medium*) is a broad layer of compact cellular tissue, which descends from the posterior edge of the body of the hyoid bone, to the middle groove of the upper edge of the thyroid cartilage.

b. Lateral thyro-hyoid ligament.

§ 2261. The *lateral thyro-hyoid* ligament (*L. thyreo-hyoideum laterale*) is oblong, rounded, and formed of longitudinal fibres. It extends

from the summit of the upper horn of the thyroid cartilage, to the extremity of the great horn of the hyoid bone. At about its centre, but generally nearer the upper than the lower edge, it contains a small rounded and oblong cartilage, or bone, (*C. tritica*), which, in fact, belongs to the class of the cartilages or bones of the tendons.

C. LIGAMENT BETWEEN THE CRICOID AND ARYTENOID CARTILAGES.

§ 2262. Each arytenoid cartilage is united by its lower face to the upper articular facet of the cricoid cartilage, by a loose synovial capsule, strengthened at intervals by ligamentous fibres.

D. LIGAMENT BETWEEN THE ARYTENOID AND ROUND CARTILAGES.

§ 2263. These two cartilages are united by a very loose, and often slightly apparent capsule, on the surface of which pass ligamentous fibres.

E. LIGAMENTS OF THE EPIGLOTTIS.

a. Epiglotti-hyoid ligament.

§ 2264. The epiglottis is united to the upper edge of the middle hyoid bone by a compact cellular tissue, termed the *epiglotti-hyoid* ligament (*L. epiglotti-hyoideum*).

b. Thyro-epiglottid ligament.

§ 2265. The *thyro-epiglottid* ligament (*L. thyreo-epiglottideum*) is strong and fibrous. It extends from the lower extremity of the epiglottis to the groove in the upper edge of the thyroid cartilage.

F. LIGAMENTS BETWEEN THE THYROID AND ARYTENOID CARTILAGES.

§ 2266. We find on each side, between the arytenoid and thyroid cartilages, one above the other, two ligaments, directed from behind forward, from above downward, and from without inward, which are situated some lines from each other, and are termed the *thyro-arytenoid* ligaments (*L. thyreo-arytenoidea*).

a. Inferior thyro-arytenoid ligament.

§ 2267. The *inferior thyro-arytenoid* ligament (*L. thyreo-arytenoideum inferius*), is much larger than the upper, and is composed of very distinct fibres. It extends from the upper and prominent end of the anterior edge of the inner face of the arytenoid cartilage, to

the lower part of the posterior face of the thyroid cartilage, and is attached in this place, directly at the side of its mate, above the groove of the lower edge.

These two ligaments are generally more developed in the male than in the female, and are termed the *vocal cords*, or *ligaments of the glottis* (*L. vocalia*, s. *glottidis*), and the fissure between them is termed the *glottis* (*glottis*, s. *rima glottidis*).

b. Superior thyro-arytenoid ligaments.

§ 2268. The *superior thyro-arytenoid* ligaments (*L. thyreo-arytenoideora superiorum*, s. *ventricula laryngis*) are situated farther outward and upward, between the centre of the anterior face of the arytenoid cartilage, and the angle of the thyroid cartilage. Those of the two sides are more remote from each other, are looser and much less evidently fibrous than the two preceding. They are distinguished only because the mucous membrane of the larynx is reflected outward, and forms a depression between them and these latter.

C. MUCOUS MEMBRANE AND GLANDS OF THE LARYNX.

§ 2269. The larynx is covered internally by a reddish and smooth mucous membrane, which is uninterruptedly continuous above with that of the cavity of the mouth, and below with that of the trachea. The outer face of this membrane contains muciparous glands, which vary in size, and are united in bundles. One of these glands, the *arytenoid* (*G. arytenoidea*), is situated before the arytenoid cartilage. Another is larger, imbedded in the midst of fat, and is termed the *epiglottid* gland (*G. epiglottidea*); it occupies the space between the epiglottis, the tongue, and the hyoid bone. It opens by from twenty to thirty excretory passages which pass through the epiglottis, and the origins of which are easily seen on the inner face of the mucous membrane and the epiglottis.

§ 2270. The mucous membrane forms on each side a considerable depression, termed the *ventricle of the larynx* (*ventriculus laryngis*). This depression is situated between the superior and inferior thyro-arytenoid ligaments; it is at most but one line deep, and two broad. It extends then much farther from before backward, than in any other direction. It is covered below by a considerable number of muciparous glands.

D. MUSCLES OF THE LARYNX.

§ 2271. The muscles of the larynx are divided into those which move the whole apparatus, and those which move some of its cartilages.

I. GENERAL MUSCLES OF THE LARYNX.

§ 2272. The general muscles of the larynx are the sterno-thyroideus and the hyo-thyroideus.

a. Sterno-thyroideus.

§ 2273. The *sterno-thyroideus* muscle (*M. bronchius*), is thin, oblong, and considerably contracted from below upward. It arises from the posterior face of the handle of the sternum, and the inner part of the posterior face of the cartilage of the first rib, ascends directly before the trachea, covered by the sterno-hyoideus muscle, and is attached by an oblique edge, formed of very short tendinous fibres, to the oblique line of the thyroid cartilage. It is generally blended at its outer part with the thyro-hyoideus muscle, and it is cleft in a greater or less extent.

Its external face generally presents, some distance from its lower extremity, a transverse or oblique tendinous intersection.

Sometimes there are two of these muscles placed one above the other.* It depresses the larynx, by acting on the thyroid cartilage. Its union with the following muscle causes it to depress the hyoid bone.

b. Hyo-thyroideus.

§ 2274. The *hyo-thyroideus* muscle has an oblong square form: it gradually contracts from below upward, and at the same time becomes thicker in the same direction. It arises from the oblique line of the thyroid cartilage, directly above the upper edge of the preceding, and ascends along the outer part of the lateral face of the thyroid cartilage, to arrive at the great horn of the hyoid bone, and is attached to the anterior part of the lower face.

It raises the thyroid cartilage and the larynx, when the hyoid bone is fixed, and depresses it when the latter is not fixed, so that it contributes by the first of these two actions, to produce acute sounds, and by the second to deglutition.

II. SPECIAL MUSCLES OF THE LARYNX.

§ 2275. The special muscles of the larynx are those which dilate and contract the glottis.

A. MUSCLES WHICH DILATE THE GLOTTIS.

a. Crico-thyroideus.

§ 2276. The *crico-thyroideus* muscle (*M. crico-thyroideus*, s. *dila-*

* Gunz, *Obs. anat.*, in the *Mém. prés. à l'ac. des sc.*, vol. I. p. 286.

tator glottidis anterior), is very small, and nearly rhomboidal, and its figure is a slightly inequilateral square. It is covered by the sterno-thyroideus muscle, and is situated between the lateral faces of the thyroid and the lower edge of the cricoid cartilage. It arises from the lower edge and the lateral face of this latter. Its fibres are directed obliquely from below upward, and from before backward, and are often divided into two distinct fasciculi, an anterior and a posterior. It is attached by a short tendon to the lower edge, and the inferior horn of the thyroid cartilage.

It is used to draw the sides of the thyroid cartilage downward and outward, so that it enlarges the glottis.

b. Crico-arytenoideus.

§ 2277. The *crico-arytenoideus* muscle (*M. crico-arytenoides*, s. *dilatator glottidis posticus*), is rhomboidal, and fills most of the posterior face of the cricoid cartilage. It arises from its whole extent, ascends from within outward, and is attached by a short tendon to the outer edge of the arytenoid cartilage.

It draws this cartilage outward, turns it a little on its axis, and thus dilates the glottis, especially at its posterior part.

B. MUSCLES WHICH CONTRACT THE GLOTTIS.

a. Crico-arytenoideus lateralis.

§ 2278. The *crico-arytenoideus lateralis* muscle is small, and of an elongated triangular form. It extends obliquely from before backward, and from below upward, from the posterior part of the upper edge of the lateral portion of the cricoid cartilage, to the lower part of the outer face of the arytenoid cartilage.

b. Arytenoides obliquus et transversus.

§ 2279. The *arytenoides obliquus* and *transversus* muscles being united very intimately, should be considered as forming a single muscle, the different layers of which do not follow the same direction.

The *oblique* fibres form the two posterior and weaker layers. They arise from the lower part of the outer edge of the arytenoid cartilage, above the insertion of the crico-arytenoideus muscle, ascend obliquely towards the opposite side, and becoming broader and thinner, are attached to the outer edge of the arytenoid cartilage of the opposite side.

The fibres which come from the left arytenoid cartilage, usually cover those arising from the cartilage on the other side.

The *transverse* fibres are partly covered by the preceding, and are attached by their two edges to the posterior face and the external edge of the two arytenoid cartilages.

All these fibres bring together forcibly, the two arytenoid cartilages, and thus contract the glottis, especially at its posterior part, in a transverse direction.

c. Thyro-arytenoideus.

§ 2280. The *thyro-arytenoideus* muscle (*M. thyro-arytenoideus*) is very elongated; it arises from the centre of the inner face of the thyroid cartilage, from the pyramidal ligament, sometimes also from the lower part of the epiglottis, goes backward and a little upward, and is inserted at the lower part of the outer edge of the arytenoid cartilage, directly above the upper extremity of the crico-arytenoideus lateralis muscle, with which it is blended.

Sometimes we observe, still higher, another and smaller synonymous muscle.

These two muscles draw the arytenoid cartilage forward, and thus contract the glottis from before backward. They diminish the extent of the glottis more than any other muscle. The fibres which go to the epiglottis, are inserted in this cartilage.

d. Thyro-epiglotticus.

§ 2281. The *thyro-epiglotticus*, or the *depressor epiglottidis* muscle, arises from the centre of the inner face of the thyroid cartilage, and is inserted on the lateral edge and the lower part of the epiglottis.

There is sometimes a smaller one, which arises farther inward and upward.

These two muscles depress the epiglottis.

E. NERVES OF THE LARYNX.

§ 2282. The nerves of the larynx arise from the pneumo-gastric nerve, and are the superior laryngeal and the inferior laryngeal or recurrent nerve. Both are distributed in the mucous membrane and in the muscles.*

* Magendie (*Physiologie*, vol. i., p. 206) and Cloquet (*Traité d'anatomie*, vol. ii., p. 622) think the first of these nerves goes wholly or nearly so to the crico-thyroidei posticus and laterales muscles, and also to the thyro-arytenoideus. Hence, whether the different muscles contract or dilate the glottis, they receive all their filaments from one of these two nerves, and completely dividing or tying them, enfeebles the voice, which is entirely lost when both are divided. Rudolphi (*Physiologie*, vol. ii., p. 375) remarks that this description is incorrect, and that we must adopt that of Andersch and Sœmmerring, whose neurology is followed by Meckel. In fact, the superior laryngeal nerve anastomoses by some twigs with the recurrent nerve within the larynx: the two nerves send twigs also to the muscles which contract and dilate the glottis, and the recurrent nerve sends some to the crico-thyroideus muscle. Andersch (*Tract. de nervis hum. corp. aliquibus*, p. i., Koningsberg, 1797, p. 50) mentions a case where the two nerves did not anastomose in the larynx, but expressly

F. FUNCTIONS OF THE LARYNX.

§ 2283. The mucous membrane of the larynx is extremely susceptible, on account of the great number of nerves which it receives, particularly in the region of the glottis. This sensibility prevents foreign bodies from entering the trachea, where they would inevitably cause suffocation. It is curious that it is so developed only at the upper part of the air-passages, and that the mucous membrane of the trachea does not possess it.

The vitality of the larynx is manifested principally by its motions, which are of two kinds. In fact:

1st. They extend to the whole system, or are confined to some of its component parts.

2nd. They move in several different cases, and are connected with several functions.

The general motions of the larynx vary its relations with the adjacent parts, according as it is drawn upward, downward, forward, or backward. The partial motions change the mutual relations of its constituent parts, and very particularly the form and extent of the glottis.

The whole larynx moves in speaking and deglutition.

During deglutition, the larynx is drawn forward and upward, as we have already explained, which prevents the food from entering it.

In speaking, the larynx rises in acute sounds, both to raise the thyroid from the cricoid cartilage, and thus to contract the glottis, and at the same time to tense its ligaments, so as to lengthen and contract the trachea. In low tones, on the contrary, it is depressed to produce opposite changes.

The partial motions are connected with deglutition, respiration and speaking.

In fact, in deglutition, the glottis is so contracted by the action of its constrictor muscles, that, even were the epiglottis absent, the food would not necessarily and constantly fall into the air-passages.

In respiration, the glottis is dilated during inspiration, and contracted in expiration; these changes constantly occur, even when the voice

states that this is not the common arrangement. When it may be as true that it is not, says Rudolphi, that the constrictor muscles and those which dilate the glottis receive distinct branches from the par vagum, what must we conclude? One nerve causes the contractions in muscles which contract and those which dilate the glottis; it is then unimportant which these muscles receive. But the fact that the same muscle receives twigs from the upper and from the lower nerve is very important, since the action may take place in one direction when a ligature or section prevents it in the opposite, and it is still more so as the pneumo-gastric nerve anastomoses above and below with the great sympathetic nerve, and above with the glosso-pharyngeal, the accessory, and the hypogastric nerves, so that the inner nerves of the larynx certainly come from several different sources. F. T.

annot be formed, on account of an opening in the trachea.* Far-ner, this is not surprising, since they coincide with analogous changes hich supervene simultaneously in the trachea, of which the larynx aust be considered the upper enlarged and more developed part.

From Legallois' experiments the closing of the glottis is the cause f rapid death in suffocation, which occurs in certain cases from di-iding the pneumo-gastric nerve or the laryngeal branch, particularly ı youth, as in such states the glottis always appears very much con-racted.†

The fact is correct, but the mode of explaining it by the paralysis of ıe arytenoidei muscles is only partially true. The contraction and ven the closing of the glottis from the paralysis of the muscles to hich the recurrent nerve is distributed, seems to depend rather on the redominance of the muscles, the nerves of which are unaltered, and ıerefore caused only in part by the paralysis.

In fact in animals of a certain age, in which the operation is less angerous on account of the size of the glottis, this opening is almost ıtirely closed after dividing the two recurrent nerves, while it is closed ıt imperfectly when the superior laryngeal nerves are cut, and the ɔwer of forming it is lost after separating all the nerves of the la-rnx.‡

The special motions of the larynx are very remarkable in forming ıe voice.

At each tone the glottis contracts, and the more the louder the tone .§ The contraction occurs particularly from one side to the other; metimes also from before backward, and often in every direction at ıce.

§ 2284. The larynx is the organ of the voice. This is proved:

1st. By the loss of voice, without any derangement in the respira-on, when the trachea presents an opening through which the air ıters and emerges in inspiration and expiration.

2nd. By the diminution or the total loss of voice when some parts of .e larynx, as the vocal cords, have been destroyed, or the arytenoid · cricoid cartilages. or the laryngeal nerves are divided.

3rd. By the differences in the voice, dependent on those in the ar-ngement of the parts of the larynx.

The voice is formed in the glottis, since the power of producing it is st when the crico-thyroid ligaments are divided, and the removal of e upper half of the arytenoid cartilages and the longitudinal section

* Bichat, *Anat. descript.*, 1802, vol. ii., p. 405.—Legallois, *Exp. sur le principe la vie*, Paris, 1812, p. 198.—L. Mende, *Ueber die Bewegung der Stimmritze im Athemholen, eine neue Entdeckung; mit beygefügten Bemerkungen uber n Nutzen und die Verrichtung des Kehldeckels*, Gripswald, 1816.

† Legallois, p. 197.

‡ Magendie, *Sur l'épiglotte*, p. 4.

§ Ferrein (*Mém. de Paris*, 1741, p. 559) has already opposed the opinion hitherto isting, viz. that the contrary is true. Bichat has followed in the same track *nat. descr.*, vol. ii., p. 408).

of the thyroid cartilage produces the same effect, which is always observed in the contraction of the glottis in crying, as the destruction of the upper ligaments has no effect on the voice, and as these ligaments likewise are always too far from each other to contract the glottis* transversely.

§ 2285. We have now to determine how the voice is formed in this place. Some suppose it is owing to the vibrations of the air, as in a wind-instrument.† Others assert that it is produced by the vocal cords, as in a stringed instrument.‡ Finally, several have combined these two theories.§

The first has been supported :

1st. By the analogy of the air-tube with a wind instrument, in which the formation of the different sounds is produced by modifying the diameter of the opening.

2nd. By the comparison with the lips, where the same conditions occur.

3rd. By different experiments proving:

a. That the tension or relaxation of the vocal cords has no effect on the acute or grave character of the sound, inasmuch as the glottis is dilated or contracted by them.

b. That when one of the vocal cords is tense and the other relaxed, they do not produce two different sounds, but one sound, the acuteness of which is proportional to the breadth of the glottis.

c. That the tone does not change when we touch the vocal cords.

d. That the contraction of the glottis is sufficient to render the tone more acute, and its dilatation to depress it, although the tension of the vocal cords does not change, and independent too of their form.

e. That the sound is independent of the force with which the air leaves the lung.

f. That no tones are formed when the glottis is very much dilated, and the vocal cords are very tense, and the air is forcibly expelled from the lung.

* E. Grasinow has asserted (*Russiche Jáhrbücher*, vol. ii., pt. i,, p. 125-143) that the voice is formed in the trachea. Burdach has refuted this absurd opinion (*same journal*, p. 153-160).

† Fabricius of Aquapendente, *De larynge*, p. ii., c. iv. *Vocis opifex, causa seu organum inquiritur.*—C. F. S. Liscovius, *Diss. sistens theoriam vocis*, Leipsic, 1814, p. 28-37.

‡ Ferrein, *De la formation de la voix dans l'homme*; in the *Mém de Paris*, 1741 p. 545.

§ Galien, *De usu partium*, vol. vii., p. 10.—Casserio, *De larynge*, book ii., ch. xiv , *De glottide.*—Dodart, *Mém. sur les causes de la voix de l'homme et de ses différens tons*; in the *Mém. de Paris*, 1700, p. 308.—Id., *Supplémens aux mémoires sur la voix et sur les tons*; same journal, 1706, p. 169 and 500; 1707, p. 83.—Dodart, however, attributes most influence to the vibrations of the air ; it is then difficult to understand why modern physiologists, even neglecting Fabricius of Aquapendente, should maintain that Ferrein's opinion was the only one admitted and present the theory as new, and more so because Ferrein directly opposes the hypothesis of Dodart.

‖ Liscovius, *loc. cit.*, p. 29-34.

The second theory is supported :—

1st. By the analogy of the vocal cords with stringed instruments.*

2d. By experiments which have proved that the extent to which the larynx was open had absolutely no effect on the acute or grave character of the sound,† while, on the contrary, the tone became acute as the vocal cords were carried outward and extended by the air leaving the lungs, and was lower when the ligaments were compressed; that it is modified in the same manner when these ligaments are fixed on several points; that the different tones are produced when the degree of tension of the ligaments is varied; finally, that similar phenomena occur when the ligaments of the larynx are entirely detached, except at their two extremities.‡

Hence, the degree of openness of the larynx would not cause a difference in the sounds, but only in the volume of the voice.§

Very probably the third opinion is most correct, although the experiments first mentioned prove, that the vibrations of the vocal cords contribute less to produce the voice than those of the air passing through the glottis; they occur simultaneously, without being necessarily connected with speaking, and the more as the larynx and trachea vibrate very evidently when the air is blown in with force, although the voice is not necessarily produced.‖

The acuteness of the voice in the female corresponds very well with the narrowness of the glottis, but not with the greater softness of the vocal cords.

§ 2256. But although the voice forms in the larynx, particularly in the glottis, the parts, however, before this opening, the epiglottis, the cavity of the mouth, and the nasal fossæ, also assist to form it.

Doubtless the principal function of the epiglottis is to close the larynx during deglutition, but very probably also it contributes to produce the voice.

In fact Haller has refused to it, contrary to the opinion of Taurry¶, and Santorini,** all agency in phonation, not because it exists before the fœtus possesses a voice,†† but because this latter is formed in the larynx, consequently below the epiglottis, and because birds sing although deprived of it.‡‡

This view of the subject is supported by some experiments, which demonstrate that the force of the voice does not change, although we cut transversely between the larynx and the hyoid bone, draw the

* Ferrein, p. 566, 569.

† Id., p. 559.

‡ Ferrein, *loc. cit.* Portal, *Exp. sur la voix*; in his *Mémoires*, vol. ii., p. 393.

§ Ferrein, p. 5[illegible].

‖ Liscovius, p. 34.

¶ *Nov. anat.*, Ulm, 1694, p. 408.

** *De larynge*, § 10.

†† Mayer, *loc. cit.*, p. 185, 186.

‡‡ *Epiglottis quidem nihil faciat ad vocem cum ea (vox), nata sit et perfecta jam, [illegible] aer ex glottidis rima prodit et absque epiglottide aves suavissime canant* (*El. phys.*, l. ix., p. i., s. v., p. 372).

epiglottis outward, and thus place the glottis directly opposite the external wound: that the removal of the top of this cartilage has no influence on the voice generally,* and that its depression, its elevation, and even its entire removal, have no effect on the character of the sounds.†

But these facts only demonstrate that the epiglottis is not absolutely necessary to phonation. Farther, the argument drawn from birds proves nothing, since their voice is formed in a lower larynx, and in them the epiglottis may be replaced by the whole trachea and by the superior glottis.

Finally, several observations and experiments, made with great care, admit the conjecture that the epiglottis alone, or together with the soft palate, contributes materially to the changes in the volume, tone, and modulation of the voice,‡ since its situation, direction, and form experience changes like those remarked in this respect in the voice, and we have no authority for admitting that these phenomena result from other changes which occur in the larynx, an opinion probably professed by Ferrein,§ since the new organ of voice he maintains can hardly be the soft palate.‖

In regard to the cavities of the nose and mouth we may remark, that the power and clearness of the voice are increased by its being retained in these two cavities, as is easily seen from the difference when the nose is stopped, or the pituitary membrane is swelled.

Farther, the different inflexions of the voice, which are termed *letters*,¶ are produced both by the larynx and the different parts of the oral cavity.

The *vowels* are formed principally in the canal included between the tongue and the palate. Their differences depend almost entirely on those in the diameter of this canal, caused by the motions of the tongue.

On the contrary, the epiglottis and the different parts of the mouth, especially the lips and the soft palate, have great effect on the formation of the *consonants*.

II. SEXUAL DIFFERENCES IN THE LARYNX.

§ 2287. The larynx is one of the organs which presents most manifestly the differences of sex. That of the female is usually one third and sometimes one half smaller than that of the male; all its constituent cartilages are much thinner; the thyroid cartilage also

* Bichat, *Anat. descript.*
† Liscovius, p. 34.
‡ Magendie, *Physiol.*, vol. i., p. 221,—Mayer, *loc. cit.*—Mende, *loc. cit.*
§ *Sur la formation de la voix*; in the *Mém. de Paris*, 1741, p. 574.
‖ Haller, *loc. cit.*, p. 455.
¶ Kempelen, *Mechanismus der menschlichen Sprache, nebst der Beschreibung seiner sprecaenden Maschine*, Vienna, 1791.

is even flatter, because its two lateral halves unite at a less acute angle. Hence why the larynx in the male forms at the upper part of the neck a prominence which is not visible in the female. From the same cause also the groove in the upper edge is much more superficial in this latter than in the male.

The glottis in the female is much smaller than in the male, and the vocal cords are shorter.

III. DIFFERENCES IN THE LARYNX DEPENDENT ON AGE.

§ 2288. The sexual differences we are about to mention do not appear until puberty: until then the larynx has precisely the same form in the two sexes, and consequently the voice is nearly the same in both. In eunuchs it is as small as in females.*

This organ developes itself much more slowly than other organs, and not proportionally with them: it seems less regular in respect to its periods, so that the larynx is sometimes smaller in some children than in others who are younger, although the growth of the others corresponds perfectly to their age.

The larynx, especially the glottis, generally continues small for a long time; thus it differs but slightly in a child of three and one of twelve years of age. But the difference is suddenly so great at the period of puberty, that in the course of a year the glottis doubles in breadth and length.†

IV. ABNORMAL STATE OF THE LARYNX.

A. DEVIATIONS IN FORMATION.

§ 2289. The whole larynx or some of its parts rarely present primitive deviations of formation.

We, however, must mention here its unusual littleness, which depends on the permanence of its primitive formation, and which coexists with the destruction or imperfect development of the testicles,‡ the absence of the epiglottis,§ the division of this cartilage,‖ the absence of the upper horns of the thyroid cartilage,¶ of the cricoid and the arytenoid cartilages,** which is very curious as it establishes an uncommon resemblance between the larynx and the trachea: the

* Dupuytren, *Bull. de la soc. phil.*, vol. ii., p. 195.

† Richerand, *Recherches sur la grandeur de la glotte et sur l'état de la tunique vaginale dans l'enfance*: in the *Mém. de la soc. méd. d'émul.*, vol. iii. p. 326.

‡ Dupuytren, *Bull. de la soc. phil.*, vol. ii., p. 195.—Meckel, *Handbuch der pathologischen Anatomie*, vol. I., p. 485,

§ Targioni Tozzetti, *Prima raccolta*, Florence, 1752.

‖ Meckel, *loc. cit.*

¶ Sandifort, *Exerc. anat.*, l. ii., ch. vii., p. 64.

** Roederer, *De fœtu paralytico*; in the *Comm. soc. Gott.*, vol. iv., p. 136.

obliquity and curve of the epiglottis;* the imperfect division of the larynx by a cord which is directed from above downward.†

The consecutive deviations of formation,‡ especially those dependent on mechanical injury, are much more common than the primitive. We must distinguish among them wounds in the larynx made by a cutting instrument in suicide. Wounds of the epiglottis are generally considered as fatal; we however have one case before us, where this cartilage was entirely divided longitudinally, and also cut transversely in its right half; but death did not ensue. This case is curious also as it proves what we stated above, that the epiglottis is not absolutely necessary to close the glottis.

Wounds of the larynx are very frequently fatal, from their consequent irritation and inflammation, on account of its great sensibility.

Sometimes death occurs at the end of a certain time, being caused by the abundant granulations which completely obstruct the glottis, and which are formed in consequence of a wound which suppurates.§

The arytenoid cartilage is partially separated by a cutting instrument, and thus, hanging in the glottis, may cause death by suffocation, like any other foreign body.‖

The cartilages of the larynx are not necessarily fractured in persons who die by hanging, although they are sometimes broken.¶

B. ALTERATIONS IN TEXTURE.**

§ 2290. The mucous membrane of the larynx either alone or with that of other parts, particularly the cavity of the mouth and that of the trachea, is often inflamed. Sometimes there is effusion, and an accidental membrane is formed, which more or less completely closes the glottis, and the patient is suffocated.

In phthisis laryngea also ulcers often exist which destroy it in a greater or less extent, and cause abnormal adhesions between it and the pharynx. This state also may cause suffocation in more than one way. But the swelling alone of the inflamed parts, without any effusion or ulceration, may be fatal.††

* *Atti di Siena*, vol. iii., p. 232.

† Meckel, *Handbuch der pathologischen Anatomie*, vol. ii., pt. ii., p. 140. The case cited by Otto (*Path. anat.*, p. 223), of a larynx divided into three, does not refer to this, but to the trachea, which presented three branches instead of two (Sandifort, *Exerc. an.*, p. 65).

‡ G. Bell, *Cases of disease and wounds of the larynx*; in his *Surgical observations*, London, 1817, p. 1.

§ Bell, *loc. cit.*, p. 44.

‖ Ibid.

¶ Morgagni cites one case of rupture of the cricoid cartilage (*Ep. anat. med.*, vol. xix., p. 13).

** Bell, *loc. cit.*,—Howship, *On the affections of the larynx*; in the *Practical observations in surgery*, London, 1816, p. 14.

†† Howship, *loc. cit.*, p. 153.

The cartilages of the larynx are more subject than any others to ossify, and consequently to be affected with all the diseases peculiar to the bones.

Among the new formations cysts are not unfrequent in this organ, although much less common than the preceding anomalies. Sometimes they belong to the class of hydatids; there is more or less danger of suffocation from them by closing the glottis.

C. FOREIGN BODIES.

§ 2291. As substances which pass into the stomach from the upper part of the alimentary canal must necessarily pass over the epiglottis, foreign bodies not unfrequently enter this organ, and thence pass into the trachea. This happens particularly when we talk while eating, as then the glottis is not closed. These foreign bodies soon occasion death by suffocation. A case however has been mentioned where a ducat continued two years in the larynx,* and another where a piece of a nut-shell as large as a finger-nail remained there seven years.†

ARTICLE SECOND.

ORGANS OF RESPIRATION.

I. NORMAL STATE.

A. LUNGS.

I. PERFECT STATE IN GENERAL.

§ 2292. The *organs of respiration* (*systema respiratorium*)‡ are the *lungs*, which communicate with the external air by the trachea. Beside the prolongations of the trachea, they are formed by the pulmonary arteries and veins, by lymphatic vessels, nerves, and cellular tissue between these two parts, and a serous envelop, the pleura.

* Hoechstetter, *Obs. med.*, dec. vi., c. x.

† Tulp. *Obs. med.*, l. ii., c. vii.

‡ M. Malpighi, *De pulmonibus epistol. I. et II. ad A. Borellum*, Bologna, 1661. —Th. Bartholin, *De pulmonum substantiâ et motu distribe. Acc. M. Malpighii de pulm. obs. anat.*, Leyden, 1672.—Helvetius, *Observations sur le poumon de l'homme*; in the *Mém. de Paris*, 1718. Wildrik, *De fabrica pulmonum*, Francker, 1761.—Wohlfahrt, *De bronchiis vasisque bronchialibus*, Halle, 1748.—Hildebrandt, *De pulmonibus*, Gottingen, 1786.—Reisseissen, *De pulmonum structura*, Strasburg, 1803.—Sœmmerring and Reisseissen, *Ueber die Structur die Verrichtung und den Gebrauch der Lungen*, Berlin, 1808.

A. FORM.

§ 2294. The *lungs* (*pulmones*) have the form of an irregular cone, the base of which looks downward and the summit upward. Their concave base rests on the diaphragm; their very convex external face is turned towards the ribs; the internal, which looks toward the heart, is concave.

The anterior edge is blunt, the posterior is sharp.

Each lung is divided into two triangular lobes, an upper, smaller, a lower, larger, by a deep groove which extends obliquely from above downward and from behind forward, and which passes entirely through it. Between these two lobes the right lung also presents a third, much smaller, which is situated forward, and contracts much from before backward. The left lung differs from that of the right side, as its lower edge presents a groove in which the lower part of the heart is situated.

Beside this difference in the form, the right lung is a little larger and lower but broader than the left, and this in return is a little more elongated.

Considered as a whole, the lung is divided into three, five, or six lobes, irregular in form and volume, in the spaces of which proceed the blood-vessels and the lymphatics, but the surface of which is not uneven, or but slightly so.

§ 2295. The posterior edge of each lung is cleft in most of its length, and thus presents a depression, the upper half of which receives the bronchiæ, the blood-vessels, and the nerves, while the ligaments of the organ are attached to the inferior.

The pulmonary artery is situated first entirely on the summit before the bronchia, and sends in this place a considerable branch to the lung; but it is soon directed backward, and passes behind the bronchia.

The pulmonary veins are found entirely forward and downward, excepting the smallest and lowest branches, which proceed behind the lowest ramifications of the bronchiæ.

B. SITUATION AND ATTACHMENTS.

§ 2296. The lungs are situated on the two sides of the heart. Each is enclosed in a special serous sac termed the *pleura*, with the parietes of which they are in perfect contact in every part, but do not adhere, except at the part where this membrane is reflected to cover their external face.

Their upper extremity passes a little beyond the first rib.

c. COLOUR.

The colour of the lungs when a person is in good health, is greyish ed, more or less spotted with black.

D. TEXTURE.

§ 2297. Among the different parts mentioned as composing the ung, the trachea is the base of the others, and also the most impor-ant, as the air passes through it to enter and emerge from the lung.

a. Trachea.

§ 2298. The *trachea* (*tracheia et arteria aspera*) is a canal about our inches long and nine lines broad, which begins at the fifth cervi-al vertebra, below the larynx, and is covered only by some muscles, articularly the sterno-hyoideus and the sterno-thyroideus. It is situ-ated exactly on the median line, passes directly before the esophagus, and descends directly into the chest, between the large vessels of the head. Thence it gradually inclines toward the right side, so that its left portion corresponds to the centre of the vertebral column, and di-vides at an obtuse angle behind the arch of the aorta, about opposite the third dorsal vertebra, into two lateral branches, termed *bronchi* or *bronchiæ*. The right bronchia is generally eight lines broad, one inch long, and the left is about half an inch broad and two long. The di-rection of this latter is more perpendicular than that of the other: it is situated between the descending vena-cava and the azygos vein. The left turns below the arch of the aorta, and goes forward.

Each bronchia is covered with the pleura, proceeds obliquely from above downward, and from without inward, toward its corresponding lung, and, on arriving there, divides into a superior and an inferior bronchia, each of which proceeds to a lobe. The lower branch of the right bronchia also soon subdivides into two twigs, a superior, which is smaller, and an inferior, which is larger, for the middle and the inferior lobe.

These canals ramify extensively within the lung, and represent a tree, terminated in every part of the surface of the organ in culs-de-sac, along which are distributed all the other component parts of the lung. The final ramifications, which are the most minute, and ter-minate in a cul-de-sac, are termed the *pulmonary cellules* (*cellulæ pulmonares*).

§ 2299. The trachea is formed by very different parts, viz. by fibrous tissue, cartilages, muscular fibres, and a mucous membrane.

a. Fibrous tissue.

§ 2300. The fibrous tissue is composed of longitudinal fasciculi, which do not form a continuous membrane, but leave between them

numerous oblong spaces. It constitutes the outer face of the trachea, and adheres intimately to the subjacent mucous membrane. Its vessels are more numerous than those in the other fibrous organs, and thus it resembles the fibrous tunic of the arteries.

From the great elasticity of this tissue, the trachea contracts to its former dimensions, after being distended longitudinally.

b. Cartilage.

§ 2301. The fibrous tissue of the trachea and of its ramifications inclose pieces of cartilage, placed successively from above downward, on the two faces of which it passes, and adheres intimately. It, however, does not cover directly the surface of these cartilages, which are entirely developed by a special perichondrium.

The form, dimensions, and situation of these cartilages, vary in different parts of the trachea, and in its ramifications.

In the trachea they form imperfect rings, open at their posterior part, which surround the anterior and lateral parts of the passage. These rings are about two lines high, half a line thick, and an inch and a half long. They circumscribe about the two thirds of the trachea when in its greatest state of distension, and more than three fourths of its circumference when it is collapsed.

The number of its cartilages varies from sixteen to twenty.

Their form is more regular and more constant at the centre of the trachea than at its upper and lower extremities. In most of this canal, they generally form rings of equal extent, and of about the same height.

The first, on the contrary, is much higher than the others, and higher at its anterior than at its posterior part. This arrangement establishes rather a remarkable correspondence from before backward, between it and the cricoid cartilage, in which there is an opposite arrangement.

This ring, also, is most generally united at its posterior extremity with the second, whence results an undoubted analogy with the type of the formation of the larynx.

Sometimes there is a similar adhesion between the third and the fourth ring, either on both sides, or more commonly on one only.

The lower rings, on the contrary, frequently present on one or both sides, a greater or less fissure, that is, one which sometimes extends to their lower extremity, and sometimes stops short of it. Frequently, but not always, we then remark on the opposite side, a small segment of an imperfect circle, which corresponds to one of the two halves formed by the division, or a ring cleft on the other side, which in some measure makes up for the want of symmetry. But we as commonly find there a common and perfect ring, or one which is partly divided in the same manner and on the same side.

The rings of the loose portion of the bronchiæ are generally similar to the final cartilaginous rings of the trachea.

There are generally but eight in the right bronchia, while there are eleven or twelve in the left. As they approach the lungs, they become more irregular, and are divided or blended with the rings adjacent.

The number of the cartilages suddenly diminishes very much within the lungs, so that the ramifications of the bronchiæ become more membranous there. But, at the same time, these cartilages lose their regular form: they cease to represent rings, and resembles layers which are irregularly quadrilateral, triangular, &c. Besides, we find them in all parts of the trachea.

They become smaller and rarer, in proportion to the gradual contraction of the ramifications of the bronchiæ. The last which are perceptible have a rounded form.

We find none in those ramifications about one third of a line in diameter, or at least they are extremely small, and scarcely perceptible.

Finally, the last ramifications of the bronchiæ are simply membranous, and some lines below the surface of the lung, we find no trace of cartilage.

c. Muscular fibres.

§ 2302. The posterior part of the trachea is formed by a muscular membrane,* which is about half a line thick when it is contracted. This membrane is composed only of two transverse fibres, which are attached to the cartilaginous rings, and to the fibrous tissue between them, so as to cover the inner face of these rings, and of this tissue about from one to two lines.

Within the lung, where the cartilages are arranged irregularly, and distributed on the whole extent of the bronchial tree, these muscular fibres surround also the whole trachea. They increase inversely as the cartilages, and they can be traced farther than these latter.

d. Mucous membrane.

§ 2303. The fibrous tissue and the muscular tissue of the trachea are covered in their whole extent by a thin mucous membrane, which forms a continuous sac, and adheres intimately to the adjacent parts.

Its posterior face presents, in the whole extent of the trachea, muciparous glands, arranged compactly, which are more numerous and larger at the lower part of the trachea, where it bifurcates; and in the portion of the bronchiæ and of the lungs. They are very near in these different parts, and they are frequently as large as a bean.

They form a continuous layer, situated mostly behind the muscular membrane, between the fibres of which their very short excretory pas-

* Eberhard, *Diss. de musculis bronchialibus corumque in statu sano vel morboso actione*, Marburg, 1817.

sages penetrate. This layer extends uniformly on the portion of the trachea formed by muscular fibres, while the glands are principally collected between the cartilaginous rings, so that, after removing these latter, we easily perceive the place they occupy by the spaces in the glandular layer.

We must distinguish from these muciparous glands, the bronchial lymphatic glands (*G. bronchiales*), which are found in the same places.

§ 2304. The mucous membrane is the last part visible among those which contribute to form the trachea and its ramifications, although reason and observation unite to demonstrate that its irritability extends beyond the points where its muscular texture disappears.

The most minute ramifications of the trachea, which are formed by a homogeneous substance, terminate in a cul-de-sac, and are not continuous, as Helvetius asserts, with the cellular tissue which unites the different organic parts of the lung. The trachea forms a hollow tree, the twigs of which communicate by the branches, and the latter by the trunks resulting from their union, but not by means of mucous tissue existing between these ramifications. This fact is established by numerous dissections and experiments.

The minutest twigs of the bronchial tree, when filled with air or any other fluid, present the same form and the same limits, either when examined with the naked eye, or with a microscope. If we fill a bronchia with air or any other fluid, so as to inject, for instance, a whole lobe, and one of the secondary twigs is afterwards tied, the part of the lung in which this latter is distributed remains swelled and distended, while that where the bronchial twig is not tied soon collapses.

b. Blood-vessels of the lungs.

§ 2305. The blood-vessels of the lungs are of two kinds. Most of the organ is formed by the *pulmonary arteries* and *veins*, the first of which carry venous blood, while the veins carry back to the left half of the heart this fluid, which has been changed by the action of the air into arterial blood, in the limit between the two systems.

The trunks of these vessels enter and emerge from the lungs at the same point.

Even within the organ the pulmonary veins are nearer the bronchiæ than the arteries are.

§ 2306. The second order of blood-vessels includes the *bronchial arteries and veins* (*vasa bronchialia*), which are connected with the nutrition of the lungs. We have already mentioned their origin. These vessels are distributed in the substance of the lung, along the ramifications of the bronchiæ, rest on their surfaces, and surround them with numerous plexuses. After supplying the muscular and the fibrous tissue, they penetrate to the mucous membrane, into which they send numerous ramuscules to the membranes of the pul-

monary vessels, to the nerves of the lungs, and form a very minute and complex tissue on the surface of all these parts, below the pleura.

It is very curious that the anastomoses occur, not only in this vascular net-work, but also between the considerable branches and twigs of the pulmonary and bronchial vessels.

The bronchial veins even mostly empty into the pulmonary. Those of the roots of the lungs alone unite in small trunks, which empty into the azygos vein, or the descending vena-cava, or into the subordinate twigs of the system of the veins of the body.

It follows then, from this arrangement:—

1st. That even in the normal state the vascular systems of black and red blood communicate extensively in the substance of the lung.

2nd. That analogous communications which appear in other parts as abnormal, as the termination of the coronary veins of the heart in the left ventricle, the insertion of one or more pulmonary veins into the vena-cava, the origin of a great pulmonary artery from the descending aorta, &c., are only a more marked development of this type.

3rd. That in the cases where the pulmonary artery was obliterated, or very narrow, and the subjects lived a long time, these anastomoses were probably large enough to carry the blood in the pulmonary arteries. In fact, the bronchial vessels were found very much dilated in a case of this kind.*

c. Lymphatic glands and vessels.

§ 2307. We have already made known the most important facts in regard to the distribution of the lymphatic vessels in the substance of the lung, and of the lymphatic glands which exist along the ramifications of the trachea.

d. Nerves.

§ 2308. The nerves of the lungs arise from the pneumogastric nerve. They are very small in proportion, but very numerous, and they can be traced far on the ramifications of the bronchiæ. They are divided into two orders. Some are distributed in the bronchial tree, others in the pulmonary vessels. The first penetrate to the muscular and mucous membranes, the second surround the vessels and penetrate either into the substance of the great trunks, or into the capillaries. Some extend even to the pleura.

e. Pleura.

§ 2309. The *pleura* is a serous membrane, the outer portion of which, termed the *costal pleura* (*pleura costalis*), covers the inner face

* Jacobson, in the *Dutsches Archiv. für die Physiologie*, vol. ii, p. 131.

of the pectoral cavity, while the internal or reflected layer, termed the *pulmonary pleura* (*pleura pulmonalis*), covers the external face of the lung.

It adheres to the parietes of the chest less than to the surface of the lung: it however can be easily detached from this latter organ.

It is composed of a right and left sac (*sacci pleuræ*), which are separate and entirely distinct.

The internal parietes of the external sac are not attached to the parietes of the pectoral cavity, but are turned towards each other, and form a septum which is directed from above downward, and from before backward, which divides the chest into a right and a left half.

These two internal parietes, however, do not touch. They are separated in the centre, and in most of the septum they form, by the heart: backward, by the aorta, the esophagus, the azygos vein, and the thoracic canal: forward, by the thymus gland and the great vascular trunks. They are united in all these parts by very loose cellular tissue; and are most remote from each other in their centre. That portion of the septum situated before and behind the heart is termed the *anterior* and *posterior mediastinum* (*mediastinum anterius et posterius*).

The *anterior* mediastinum descends between the heart and the middle anterior part of the thoracic cavity. Its direction is not perpendicular, but oblique from left to right. Besides, it does not correspond perfectly to the median line, but is thrown a little to the left, for the anterior edge of the right layer is attached to the left edge of the sternum, and that of the left layer to the cartilage of the left ribs; thence the mediastinum descends on the anterior face of the pericardium.

The *posterior* mediastinum is more perpendicular than the anterior, and is situated between the anterior face of the vertebral column and the base of the heart.

The external layer of the pleura of each side is reflected on itself, between the two mediastina, to pass on the lower and upper faces of the lungs. For this purpose, it contracts around the pulmonary vessels and the bronchiæ, and descends from the centre of the posterior edge towards the lung. Upward, forward, and backward, it contracts suddenly, and from all parts towards this point; but we observe below, on each side, a considerable triangular prolongation, terminated by a lower semicircular edge, which begins at the diaphragm, and is attached to the posterior edge of the lower lobe of the lung. This prolongation is termed the *right and left ligament of the lung* (*l. pulmonis dextrum et sinistrum*). That of the left side is much larger than that of the right.

The pulmonary pleura covers the whole surface of the lung, even its lobes, but does not penetrate between these lobes, which are separated from each other only by cellular tissue.

f. Weight of the lung.

a. Absolute weight.

§ 2310. The sound lung of an adult male, with all the blood and air it contains, weighs about four pounds. When removed from the body, the pressure of the external air, which had been prevented from acting on it, expels a considerable portion of this fluid which remained in it after the last expiration.

Its weight then is to that of the whole body about as 1 : 35.

b. Specific gravity,

§ 2311. Considered in itself, the substance of the lung is heavier than water, for the lungs of a child which has never breathed sink in this fluid. But when respiration has commenced the specific weight of the organ is less than that of water, as the air which enters there is not entirely expelled during expiration. We cannot even press it out from a section of the lung: for then, after rupturing the ramifications of the bronchiæ, it extends in the cellular tissue, so that at the end of the experiment the substance of the lung is still lighter than the water, although a little heavier than it was before.*

g. Capacity.

§ 2312. The capacity of the lung is not the same in all periods of life. It varies much, according as the organ is distended at the end of *inspiration* (*inspiratio*), or in that of contraction, at the end of *expiration* (*expiratio*).

The estimates given by authors vary, which may arise from a real difference in the capacity of the lung and the nature of the modes employed to estimate it.

In the first respect there are very great individual differences, which are mostly congenital, but which may be accidental, as when the lungs are but slightly used, for instance, in students.

The capacity of the lung is determined by adding the quantity of air expelled during expiration with that which remains there after this act is completed. This calculation may be made in several different ways.

Three processes can be used to determine the quantity of air which enters the lung at each inspiration:

1st. We may measure the enlargement of the lung in inspiration, and the contraction after expiration.

* Allen and Pepys, *Second paper on respiration*; in the *Phil. trans.*, 18[illegible]9, p. 41.

2nd. We estimate the changes which supervene during inspiration and expiration in a fluid in which the individual is situated.

3rd. We measure the quantity of the air inspired and expired, by inspiring from a vase which has been measured, and expiring into another, the capacity of which is also known, or by the last proof alone.*

At present the estimates of the quantity inhaled and expelled at each respiration varies much, from three to forty cubic inches. In fact, Abildgaard estimates it at three inches;† Wurzer‡ and Lametherie,§ at eight or ten; Keutsch,|| between six and twelve; Abernethey,¶ Lavoisier, Seguin,** and Davy,†† at thirteen; Borelli‡‡ and Goodwyn,§§ at fourteen; Kite,|||| Allen and Pepys,¶¶ at seventeen or eighteen; Herholdt,*** between twenty-five and twenty-nine; Cavallo,††† Jurin,‡‡‡ Sauvages,§§§ Hales,|||||| Haller,¶¶¶ Chaptal,**** Bell,†††† Fontana,‡‡‡‡ Menzies,§§§§ and Richerand,|||||||| between thirty and forty cubic inches.

In estimating the quantity of air remaining in the lung after expiration, the following circumstances are attended to:

1st. After expiration, as long as the chest remains closed and the lungs are not removed, these organs contain more air than when separated from the body, because they collapse after opening the chest, and thns expel the air they contain.

2nd. It is very difficult to expel the air which remains in the lung, and it can never be completely removed by the greatest possible pressure.

* Jurin, in Haller, *El. phys.*, l. viii., s. iii.

† *Neue Versuche über das Athmen und den Nutzen desselben*; in the *Nordisches Archiv. für Natur. und Arzneywissenchaft*, vol. i., pt. 1., p. 2.—Abildgaard however asserts in another place (*ibid.*, pt. ii., p. 206), that from two to seven, and sometimes even fifteen cubic inches enter.

‡ Gunther, *Darstellung*, p. 28.

§ *Journ. de physique*, vol. xlvi. p. 108.

|| *De act. gaz oxygenii per pulm. resp.*; Copenhagen, 1800.

¶ *Essays*, London, 1793, vol. ii., p. 144.

** *Mémoire sur la respiration*, &c.

†† *Researches concerning nitrous oxyd.* London, 1800, p. 433,

‡‡ *De motu animalium*, p. ii., prop. 81.

§§ *Recherches expérimentales sur les effets que produisent sur les animaux vivans la submersion, la strangulation*, &c. Paris, 1798.

|||| *Ueber Wiéderherstellung scheinbar todter Menschen*, p. 19.

¶¶ *Loc. cit.*

*** *Nordischés Archiv.*, vol. i., pt. ii., p. 207.

††† *Ueber Anwendung der Gasarten.*

‡‡‡ *Diss. phys. math.*, London, 1732, diss. iv.; in Haller, *De part. corp. hum. fab.*, vol. vi. p, 325.

§§§ In Haller, *El. phys*, vol. iii., p. 234.

|||||| *Statistical Essays*, vol. i., p. 238.

¶¶¶ *El phys.* vol. iii., *loc. cit.*

**** *Chemie*; in *Bostock, Ueber das Athmen*, p.189.

†††† *Anatomy*, vol. ii., p. 193.

‡‡‡‡ *Phil. trans.*, 1799, p 349.

§§§§ *De respiratione*, Edinburgh, 1790.

|||||||| *Physiologie*, vol. i., p.374.

Several methods have been proposed to estimate the quantity of air which remains in the lungs after respiration.

1st. After fixing the diaphragm as firmly as possible, the abdomen is tied and the lungs collapsed, by making an incision in the parietes of the chest, we fill the space between these parietes and the organ with water, which it is asserted should be equal in quantity to that of the air expelled from the lung by the pressure of the liquid, and also that of the external air introduced into the chest through the parietes.

2nd. On opening the lung the air is received from it in a bladder adapted to the trachea, and it is measured;* the lung is then immersed in water, the specific gravity of which is about equal to that of distilled water, while its absolute weight is known: the quantity displaced is weighed, and we determine the cubic quantity of air it still includes.

From these two methods we may conclude the quantity of air remaining in the lung of an adult after a complete expiration to be about one hundred and ten cubic inches. In fact, Goodwyn has introduced from ninety to one hundred and twenty cubic inches of water in the space between the chest and the lung.

In Allen and Pepys' experiments, the quantity of air first collected was 31.580 cubic inches: the lungs, which weighed four pounds, and which from their weight occupied as much space as an equal quantity of water, displaced six pounds of the liquid, so that there still remained within them a quantity of air equal to an ounce of water, that is, 59.554 cubic inches. The total of these two sums gives a little more than ninety-one cubic inches, as the quantity of air remaining in the lung after expiration; but we may admit it as about one hundred and ten, on account of the pressure of the water on the mass of the lung, and the higher the temperature during life.

If we add to these one hundred and ten cubic inches of air remaining in the lung after a common expiration, about thirty inches which leave the organ at each common expiration of a healthy adult,† we shall have one hundred and forty-five inches as the capacity of the lungs in common inspiration, so that the difference of capacity between the state of dilatation and collapse of the organ is about thirty-five inches.

But this difference increases very much when the respiration being deeper, the lung is unusually dilated and collapsed, because more air enters and leaves the lung at each time.

* Cline, in Allen and Pepys, *loc. cit.*

† We take this as the mean number: it seems to us that a lower estimate should be ascribed to an unusual smallness in the lung; or to careless calculation, and that a greater estimate depends upon an unusual development of the chest, or on a very deep respiration. Farther, we ought to mention that the air is dilated one sixth by the heat of the body.

Thus Seguin* inhaled in a very deep respiration one hundred and thirty inches of air, which would expand by the heat of the body to one hundred and fifty, so that then the capacity of the lung was equal to two hundred and sixty cubic inches. Kite estimates the capacity at three hundred cubic inches.

On the other hand, Jurin expired two hundred and twenty cubic inches,† and Herholdt, two hundred and eight.‡ If we admit here that these expirations took place after a full inspiration, we ought to reduce the capacity of the lung to fifty-two and even to forty cubic inches, which estimate perfectly agrees with that formed by Davy by another method.§

In contrasting the estimates of Seguin and Jurin, and disregarding the diminution of the volume of the air expired, we find a difference of two hundred and twenty between the greatest dilatation and the greatest relaxation of the lung, that is, this latter state is to the other as 1 : 6.5.

h. Force of the lung.

§ 2313. The lung is not very sensible. Its transverse and its longitudinal muscular fibres, which are similar in their nature to muscles, give it the power of contracting, which, judging from expements,‖ is exerted whenever its external or internal surface is stimulated, and which without stimulation¶ executes the motions which cannot be attributed to those of the parietes of the thorax, since they are simultaneous with these latter, and are observed when the parietes of the thorax are destroyed.** Consequently the air-passages contract actively during expiration;†† but all these phenomena, adduced to prove that the lungs possess a power of extension which allow them to dilate actively in inspiration, can be satisfactorily explained in another manner.‡‡

* *Observations générales sur la respiration et sur la chaleur animale*; in the *Journ. de physique*, 1790, p. 467.

† In Haller, *loc. cit.*, p. 326.

‡ *Loc. cit.*, p. 41.

§ *Loc. cit.*, p. 409.

‖ Varnier, in the *Mém. de la soc. roy. de méd.*, ann. 1779.

¶ Rudolphi, *Ueber das Athemholen*; in his *Anat.phys. Abhandlungen*, p. 111. —Flormann, *ibid.*, p. 110.

** Bremond, *Expériences sur la respiration*; in the *Mém. de Paris*, 1739, p. 455. —This author however adduces as proofs several phenomena which are by no means conclusive.

†† J. Carson, *Mémoire sur l'élasticité des poumons*; in the *Arch. gen. de méd.*, vol. ii., p. 134.

‡‡ J. D. Herholdt, *Ueber die chirurgische Behandlungen der Brustwunden, veranlasst derch neue Versuche über den Mechanismus des Athemholens*; in the *Nordisches Archiv.*, vol. ii., pt. i., p. 44.60.

i. Function of the lung.

§ 2314. The function of the lung is respiration, which consists essentially in the change of venous into arterial blood by the expulsion of carbon and the absorption of oxygen. The atmospheric air enters into the organ during inspiration, and emerges from it loaded with carbonic acid during expiration; this change of the blood, and the cold produced by the evaporation of the water exhaled, are the most important functions of the lungs; but the variations in its capacity also affect the circulation, for the blood circulates more rapidly from the right half of the heart into the pulmonary artery during inspiration, and from the pulmonary veins into the left portion of the heart during expiration.

II. SEXUAL DIFFERENCES.

§ 2315. The lungs of the male are larger than those of the female, and the latter are more oblong than those of the male.

III. DIFFERENCES DEPENDENT ON DEVELOPMENT.

§ 2316. The lung presents considerable periodical differences,* in respect to its existence, situation, texture, colour, contents, volume, and finally its absolute and relative weight.

1st. *Existence.* The lung is one of the last organs to appear. It begins to be distinctly seen about the end of the second month of pregnancy.

2nd. *Situation.* From the greater proportional volume of the heart and its slight development, the lung is situated much more posteriorly before than after birth, so that sometimes it is not seen at all on opening the cavity of the thorax; consequently it covers the pericardium, and generally does not entirely fill the sac of the pleura, and hence does not touch the parietes of the chest.

3rd. *Texture.* At the third month of pregnancy we begin to distinguish the cartilaginous tissue in the air-passages of the lungs. The lobules are at first united by a looser cellular tissue than that commonly seen, and they are also formed of small subordinate lobes, so

* Meckel, *Mémoire sur le developpement du cœur et des poumons dans les mammifères*; in the *Journ. compl. des sc. méd.*, vol. i., p. 259.—Consult also on the difference in the lung of the child before and after respiration, G. J. Schmitt, *Neue Versuche und Erfahrungen über die Plocquetsche und hydrostatische Lungenprobe*, Vienna, 1806.—A. Lecieux, *Considerations medico-legales sur l'infanticide*, Paris, 1811.—Magendie, *Sur la structure du poumon de l'homme, sur les modifications qu'éprouve cette structure dans les divers âges, et sur la première origine de la phthisie pulmonaire*; in the *Journ. de physiol. experim.*, vol. i., p. 78.—Fleischmann, *Sur la formation de la trachée-artère*; in the *Journ. compl. du dict. des sc. med.*, vol. xvi., p. 141.—Id. *De chondrogenesi asperiæ arteriæ et de situ œsophagi abnormi nonnulla*, Erlangen, 1820.

that here, as in other parts, as the muscles, the homogeneous mass is at first divided into its great subdivisions, but afterward into the smaller parts.

4th. *Colour.* The colour of the lung is at first reddish white in the fœtus, and is whiter the younger the fœtus is. This organ gradually becomes of a deeper red, in proportion as it is better supplied with blood. After birth this tint is bright from respiration, and also becomes deeper. At twenty years the lung is grey, mottled with blue and black spots, and from this time its colour becomes still darker, so that in advanced life it is more or less generally black or bluish black.

5th. *Contents.* The trachea and its ramifications contain after birth only air, and a small quantity of aqueous vapour and mucus. But this is not true of the fœtus, where it is filled with the fluid of the amnion. By the laws of hydraulics, when the fœtus swims in this fluid it enters the trachea, without any respiratory motion on the part of the fœtus. It usually escapes after birth, and when it does not escape at this time, which is rare, it may suffocate the child.*

6th. *Volume.* The lung is at first much smaller; it occupies much less space than the heart, and is easily blended with the very dilated auricles of this latter.

It does not acquire its normal proportional size till puberty.

7th. *Weight.* The absolute weight of the lung presents very remarkable periodical differences, which depend on the organ remaining inactive until after birth. In the fœtus its specific gravity is greater than that of water, in which it sinks; but when respiration has once commenced, as it is never free from the air which has entered in it, its specific gravity is less than that of the water, and it floats.

§ 2317. Most of the differences mentioned, especially those in regard to situation, volume, colour, and specific gravity, appear more or less at birth, and result from respiration.

The lung, becoming lighter from the effect of the air entering it and which never entirely leaves it, occupies also more space after respiration, and is situated more anteriorly, covers most of the pericardium, and is in contact with the parietes of the chest. The deep red colour communicated to it by the venous blood before respiration, changes to a bright red when the new being breathes.

Finally the organ, which when collapsed received less blood, and was consequently lighter, becomes heavier when, after being distended by respiration, it is more permeable to the blood.

Hence these differences have been thought sufficient to determine whether an infant was born living or dead. But as the specific gravity having diminished, the lung floats, which proof constitutes what

* P. Scheel, *Commentatio de liquoris amnii asperiæ arteriæ fœtuum humanorum naturâ et usu ejusque in asphyxium neonatorum et medicinam forensem influxu*, Copenhagen, 1799.—Herholdt, in Reil, *Archiv. fur die Physiologie*, vol. iii., p. 168—Id., in the *Nordisches Archiv.*, vol. i., p. 212.

is termed the *test hydrostatica*;* as also the afflux of the blood increases the absolute weight of the organ, and its relative weight compared to that of the body constitutes another kind of proof, termed the *test by the balance*,† this principle has been laid down, that when the lungs of a child swim in water, and a similar or analogous proportion exists between the relative weight of the lungs and that of the body, it is established that this child was born alive and that it breathed.

Considered generally and absolutely, these conclusions are correct; but great and important restrictions are necessary.

1st. The lungs may become lighter by respiration, and the child not be born.

2nd. The lungs may swim from some other cause than respiration.

3rd. Respiration does not necessarily produce this change in them.

4th. The lungs sometimes have a greater absolute weight, although respiration has not taken place.

5th. On the other hand, they may present after respiration a specific gravity as great as that they possess, according to the general opinion, before this act.

In fact:—

1st. The infant sometimes breathes sufficiently during parturition to render its lungs capable of swimming, although it may be still-born.‡

2nd. The lungs may also swim from the fact that the air has been pushed into them, through the mouth or nose, either while they continued in the thorax, or after their removal from this cavity. Putrefaction also may give rise to the same result.

3rd. Several experiments demonstrate that respiration does not necessarily cause in the lungs the above mentioned changes. Some parts of a lung, or even an entire lung, have been seen which did not swim in water, although the child has lived, breathed, and cried, not only for several days,§ but even for six weeks. We have seen in a child six weeks old all the middle lobe of the right lung, and in another four weeks old, great portions of the same lobe apparently healthy, which were absolutely incapable of floating.

The left lung is most frequently retarded in its development, which peculiarity doubtless depends on the fact that the right bronchia is much shorter and broader than the left, so that usually, even in children who died soon after birth, the right lung floated, while the left floated very imperfectly, or not at all.‖

* F. Alberg, *De docimasiâ pulmonum hydrostaticâ*, Halle, 1791.

† G. G. Plocquet, *Comm. med. in processus criminales super homicidio infanticidio et embryoctonia*, Strasburg, 1787.

‡ Schmitt, (*loc. cit.*, p. 150-176) has reported examples of this.

§ Kaltschmied, *De exp. pulm. infant. aq. injectis*, ann. 1751.

‖ A. Portal, *Mémoire dans lequel on démontre l'action du poumon sur l'aorte pendant le temps de la respiration, et où l'on prouve que, dans l'enfant qui vient de*

It is at least very rare that the contrary occurs.

a. The rarest case is when the cause of the sinking of the lung depends on a morbid alteration in its texture, an effusion, an induration, for these are very unfrequent before birth, and even when they occur to a great extent, the organ does not acquire a greater specific gravity than that of water.

b. A more common cause is the presence of foreign bodies, especially mucus, and the fluid of the amnion in the trachea, or the feebleness of the fœtus, all which circumstances render the dilatation of the lung imperfect.

c. We must remark also that this change in the specific gravity supervenes gradually, and when the respiration takes place with the requisite degree of strength, as in the beginning, and when the child respires but feebly, it extends to some parts of the lung only, and sometimes it is not produced at all by the first inspirations.

4th. Sometimes, although the child has not breathed, the lungs have an absolute and consequently a relative weight, in proportion to the body, as great as when the child has respired. There are some cases where the relation between the weight of the lung and the body is still greater, for instance, as 1 : $15\frac{1}{4}$, to $29\frac{20}{63}$, to $33\frac{5}{9}$, to $32\frac{11}{53}$, to $34\frac{75}{131}$,* although respiration did not take place.

This circumstance is still more curious, as the lungs contained also more blood than usual.

5th. Observation likewise proves that the lungs of infants born alive are sometimes proportionally lighter than those of still-born children are, according to the preceding estimate,† as they are found in the proportion of 1 : $77\frac{9}{11}$, to $77\frac{19}{88}$, and to 104.

II. ABNORMAL STATE.‡

§ 2318. *Primitive deviations of formation.* The lungs present proportionally but few anomalies resulting from a primitive deviation of formation; they however sometimes manifest them in respect to quantity and quality.

1st. The congenital anomalies in regard to quantity are generally.

a. Deviations of formation from an arrested development. Here are arranged particularly:

a. The *absence* of the trachea, of a lung, or of the two lungs; this last anomaly usually attends acephalia vera; the second is more

naître, le poumon droit respire avant le gauche; in the *Mém. de Paris*, 1765.—Some writers have attributed this discovery to Petit, but wrongly: he mentions only one case (*Mém. de Paris*, 1753), and does not point out the real cause of the phenomenon.

* Schmitt, *loc. cit.*, p. 138.

† Id. *ibid.*

‡ Van den Bosch, *Commentatio exhibens anatomiam systematis respirationi inservientis pathologicam*, Harlem, 1801.

ure, and also occurs in subjects whose formation is otherwise normal, nd resembles the normal singleness of the lung in several serpents. The absence of the trachea is less common than that of the lungs; when it occurs the lung is situated next to the larynx, as also in several reptiles.

b. *Narrowness* and *closing* of the trachea, which has been observed when the skull was deficient.*

c. The *smallness* of one or of the two lungs. The first anomaly is enerally produced mechanically by an external obstacle, particularly he presence of the abdominal viscera in the cavity of the thorax in a ubject affected with diaphragmatic hernia. The second, which is enerally connected with narrowness of the thoracic cavity, depends n a primitive dynamic anomaly of the formative power, and somemes occurs in individuals otherwise well formed, and sometimes is ttended with other deviations in formation, arising from suspended evelopment.

d. We ought also to mention here the exposure of the lungs or achea sometimes observed, since it depends upon the formation of ie parietes of the thorax bein arrested at one of the early periods rough which it successively passes.

b. The great size of a lung, attended generally by the deficiency the other, results from an excessive action in the formative power.

2nd. Congenital deviations in form relative to the quality are :—

a. The *abnormal division*, which is indicated in the lungs by the esence of an unusual number of lobes, or by the deeper separation those always existing, and in the trachea by its division into three ranches. This last anomaly, judging from facts hitherto collected, curs only on the right side, and is curious as a repetition of the eculiar structure of the ruminantia and the cetaceous animals.

b. An opposite anomaly occurs when the lungs are not divided to lobes as usual, or when this division is not clearly indicated.

c. Lateral inversion is where the right lung has but two lobes and e left three. This anomaly commonly occurs only when there is general lateral inversion.

Consecutive deviations of formation. The pure consecutive accidenal deviations of formation are particularly *wounds*, which often sudenly cause death, on account of the considerable calibre of the vessels, but sometimes death occurs from the dangerous inflammation and uppuration of such important organs; but they are not necessarily or always fatal.

We must mention here the abnormal communication with the other avities, which sometimes occur when the parietes are destroyed; e most remarkable is that which occurs in aneurism of the aorta.†

* Otto, *Monst. sex. disq.*, p. 10, 11.

† Richerand, *Observations sur l'ouverture des anévrysmes de l'aorte dans la achée-artère et dans les bronches*; in the *Mém. de la soc. méd. d'émul.*, vol. iv., 515.

In this case, from the respective situation of the parts, the opening usually corresponds to the lower part of the trachea, or to the left bronchia.

§ 2319. *Alterations in texture.* They are:—

1st. Inflammation, generally termed *pneumonia*, *bronchitis*, and *pleuritis*, according as the whole substance of the lung, the mucous membrane of the trachea, or the pleura, is affected.*

The most usual consequences of pneumonia are:—

a. Thickening and *induration* of the tissue of the lungs, from an effusion often existing in a great degree, and then forming the state termed *hepatization* (*hepatisatio*)†. The substance of the lung is then generally homogeneous, friable, brittle, greyish white, much thicker in texture, and sometimes possesses a specific gravity greater than that of water.

2nd. *Suppuration.* Pus usually burrows for itself a passage into the bronchiæ. More rarely it is effused into the chest, constituting *empyema*, or into the adjacent organs, as the pharynx or the aorta.‡

Bronchitis terminates sometimes by suppuration, sometimes by the formation of solid or hollow membranes, which fill this cavity and rarely adhere to its inner face. Very probably, however, the development of these accidental membranes is not always and necessarily preceded by an inflammation of the trachea.§

The consequences of pleuritis are:—

* C. Hastings, *A treatise on inflammation of the mucous membrane of the lungs*, London, 1820.—T. Alcock, *Observations on the inflammation of the mucous membrane of the organs of respiration*, London, 1820.

† Bricheteau, *De l'hépatisation pulmonaire*; in the *Journ. compl. des sc. méd.* vol. ix., p. 166.

‡ V. Laennec, *De l'auscultation médiale*, vol. i.—Andral, *Clinique médicale*, vol. ii.—Louis, *Observations relatives à la perforation du parenchyme du poumon*; in the *Archiv. gén. de méd.*, vol. v., p 321.—Bouillaud, *Nouvelles observations sur la gangrène des poumons*; in the *Revue médicale*, vol. iv., p. 375.

§ This proposition cannot be admitted. It rests upon a fact mentioned first by Bayle, and since enlarged upon by Andral, that sometimes in individuals affected with chronic bronchitis, even with an expectoration of pus, the mucous membrane is hardly rosy or even perfectly white in its whole extent. But ought not we then to admit that the tissue is discoloured after death? Farther, it is remarkable that the softening and ulcerations are much more rare in the mucous membrane of the bronchiæ than in that of the intestine, and that the frequency of the ulcerations decreases from above downward. The inflammation of this membrane frequently terminates also in thickening, which causes the contraction of the bronchiæ. Hypertrophy even sometimes extends more or less to the external fibrous and cartilaginous tissues. We must not confound the contraction of the bronchiæ, which results from it, with that which comes from the compression of these canals by a tumour, among others by tumefied ganglions, which are rather common in children, or by an aneurism of the aorta. Chronic inflammation results also in a dilatation of the bronchiæ, to which Laennec first attracted attention, and which has been studied very carefully since by Andral, as have also the different alterations in the secretion of the mucous membrane of the bronchiæ. Consult on this subject: Laennec, *De l'auscultation médiate*, Paris, 1819, vol. i., p. 124.—Andral, *Observations sur quelques altérations organiques des bronches*; in the *Archiv. gén. de méd.*, vol. iv., p. 514.—Id., *Clinique medicale*, vol. ii., p. 1-85.—Bree, *Recherches sur les désordres de la respiration*, Paris, 1819.—Desrulles, *Traité théorique et practique du croup*, Paris, 1824.

a. Thickening, induration of this membrane.

b. Effusion of serum, which when not coagulable in a great de- ree, causes *hydrothorax*, and which when coagulable produces the ıutual adhesions of the contiguous surfaces of the pleura.*

The principal new formations in the lungs are *tubercles*

3rd. The repetitions of the normal tissues in the respiratory organs re rare. We must, however, refer to this the accidental membranes eveloped after pleuritis, because they are repetitions of the cellular ssue and the accidental ossifications† formed in the osseous tissue. 'hese ossifications frequently appear as thin elongated laminæ, si- ıated on the outer face of the pleura. They are more rare on the ıner face of this membrane, in the form of rounded bodies, which at rst adhere, but are finally detached. The pretended change of the ulmonary substance into cartilage is probably in most cases only an ıduration resulting from effusion. Sometimes however cartilaginous ssue is really developed accidentally in the lungs.

§ 2320. *Foreign bodies.* These are:—

1st. Entozoaries, particularly hydatids which form in the substance r on the surface of the lung, and the hamularia subcompressa which xists in the trachea.

2nd. Foreign substances accidentally introduced into the air pas- ages.

ARTICLE THIRD.

CAVITY OF THE THORAX.

§ 2321. The thoracic cavity contains, besides the lungs and their ssels, the heart, the commencement of the aorta, the trunks of the cending and descending venæ-cavæ, the azygos vein, the thoracic nal, the esophagus, and the thoracic portion of the ganglionnary rve. We have mentioned previously the manner in which it is rmed like a cage. Its upper extremity is generally the narrowest ıd its lower extremity the broadest part of the chest: at least it is nerally much broader at its base than at its summit. It is convex the sides, flattened forward, larger from above downward, and orter from before backward than in any other direction, much longer steriorly than anteriorly, and provided below with a more or less nvex floor which is formed by the diaphragm. Posteriorly the dies of the dorsal vertebræ imperfectly divide it into two halves.

* Laennec, *loc. cit.*, vol. i.—Andral, *loc. cit.*, vol. ii.—Id., *Observations sur l'in- m...ation de la plèvre diaphragmatique*; in the *Archiv. gén. de méd.*, vol. iii., 246.

† Rullier, *Note touchant un très grand nombre de pièces osseuses développées ns le tissu du poumon*; in the *Archiv. gén. de méd.*, vol. v., p. 271.

It is a little shorter on the right than on the left side, on account of the prominence of the liver.

The inner face of its parietes is covered in nearly its whole extent by the external layer the pleura, which is there attached to it by a very short cellular tissue. Of the organs it incloses, the lungs and the heart are united to it by its surrounding serous membranes; the others directly by cellular tissue.

The division into a right and a left half, indicated by the bodies of the vertebræ, is completed by the mediastinum.

I. MOTIONS OF THE CHEST.

§ 2322. The chest is continually extended, enlarged, contracted; and the first state occurs in inspiration, and the second in expiration The motions of the chest which determine them, produce a simultaneous dilatation and contraction in the air passages. The lung, being compressed when the chest collapses, expels the air within it, while it enters through the mouth and nose, when, the chest dilating, the obstacle from the collapsing of its parietes no longer exists.

The dilatation of the chest during inspiration, and its contraction in expiration, occur in every direction.

The greatest change is that in height. It depends partly on the depression of the diaphragm in inspiration, and its rising in expiration, partly also on the raising of the ribs by the intercostales and scaleni muscles.

The enlargement in the direction of the breadth, depends on the ribs being drawn outward.

The parietes of the chest follow exactly the motions of the lungs during respiration, and these two parts remain in contact, at least in the regular state, during expiration or inspiration, so that they are found in perfect contact after the strongest of all expirations, that which occurs at death.

II. DIFFERENCES DEPENDENT ON SEX.

§ 2323. The chest of the male is much larger than that of the female, as it is longer, broader, and deeper. Its capacity is also more uniform, so that it is proportionally a little broader, rounder, and more movable. The bodies of the dorsal vertebræ do not project as much.

III. DIFFERENCES DEPENDENT ON DEVELOPMENT.

§ 2324. The chest is proportionally the smallest of the three sphlanchnic cavities of the body during the early periods of existence, which depends particularly on the slight development and the inactivity of the lungs.

It possesses in the same proportion a greater degree of elasticity, because the costal cartilages are much longer in proportion to the ribs, than during the successive periods.*

It does not begin to move until after birth, and when the new being breathes for the first time.

IV. ABNORMAL STATE.

§ 2325. Sometimes the chest is only partially closed, from a primitive deviation of formation. When this anomaly exists on the anterior face or the sides, the internal organs are exposed; when in the lower wall, the abdominal and pectoral cavities abnormally communicate, and some of the thoracic viscera enter the cavity of the abdomen. The same also may be caused later by wounds, ulcers, &c. A common congenital deviation of formation is the abnormal smallness of the chest, which generally attends a corresponding defect in the development of the lung, and a disposition to tuberculous phthisis.

The alterations in the texture of the chest are principally different kinds of tumors, which occur in the mediastinum. These tumors sometimes become large, and compress the organs in the thoracic cavity so much, that the subject dies from the suspension of the circulation or nutrition.†

ARTICLE FOURTH.

GLANDULAR ORGANS SITUATED NEAR THE ORGANS OF VOICE AND RESPIRATION.

§ 2326. We find near the organs of voice and respiration, two imperfect glands,‡ the *thyroid* and the *thymus* glands, which are similar not only as they both present the general characters of glands of their species, but also because they are situated directly on the median line, behind the anterior face of the body, before the organs of respiration, and because they even touch in the early periods of fœtal existence.

These two glands possess numerous blood-vessels and lymphatics. They have no excretory ducts, but contain in their spaces a fluid different from their substance, and which is very evident in the thymus gland. The change of a considerable quantity of blood, which is pro-

* Compare the measures in regard to this subject, in Lobstein, *Sur la première respiration de l'enfant nouveau né*; in the *Journal de Médecine*, vol. xxxv. p. 1, 312.

† Laennec, *Sur le rétrécissement de la poitrine à la suite de certaines pleurésies*: in his *l'Auscultation médiate*, vol. i. p. 369.

‡ P. H. Boecklen, *De thyroideæ, thymi et glandularum suprarenalim functionibus*, Strasburg, 1753.—J. F. Meckel, *Ueber die Schilddrüse, Nebennieren und einige ihnen verwandte Organe*; in his *Abhandlungen aus der menschlichen und vergleichenden Anatomie*, Halle, 1816, p. 1-277.

bably peculiarly modified, and the formation of their fluid, are the only functions which can be assigned to them with certainty. We then have reason to think their functions in the sanguineous system are analogous to those of the lymphatic vessels, that is, they are organs which contribute to perfect the formation of blood. This conjecture is rendered probable from the fact, that the blood which passes through their tissue, and the fluid which they prepare, soon enter the venons blood near its entrance into the lung.

I. THYROID GLAND.

A. PERFECT STATE.

§ 2327. The *thyroid gland* (*G. thyroidea*)* is situated forward and on the sides of the upper part of the trachea and pharynx.

It is composed of a centre, which is slightly contracted, thin, and about four lines high, termed the *isthmus*, and of two lateral portions or *horns*, which are directed from below upward, and terminate in a point.

The central part is situated directly below the larynx, and before the three or four upper rings of the trachea. The two horns extend below to the sixth or seventh ring, and above to the lower horn of the thyroid cartilage.

There is generally detached more or less from its centre, a median horn, which is generally single, rarely double, termed by Lalouette the *pyramid*. This horn is rarely perfectly cylindrical, and generally corresponds to the left side more than to the right†, which deserves to be remarked on account of the greater development of the hyoid bone, generally occurring on the same side. It re-ascends before the thyroid cartilage to the middle hyoid bone, and it terminates there, gradually becoming thinner. This horn exists more frequently than it is deficient.‡ We must then attribute to accident, or to careless dissection, the assertions of authors to the contrary.§

§ 2328. It is generally surrounded by a special and unmated muscle, the *levator gland, thyroideæ* muscle, the upper extremity of which is generally attached to the body of the hyoid bone; some-

* P. Evertze, *De glandulâ thyroideâ*, Leyden, 1708.—Santorini, *Obs. anat.* ch. vi-xvii.—Duvernoy, *Obs. anat.* 2, 3, 4; in the *Comm. Petrop.*, vol. vii. 1740, p. 216-218.—Lauth. *De glandulâ thyroideâ*, Strasburg, 1742 —Morgagni, *Ep. anat.*, Venice, 1763, vol. ix. § 30—40.—Uttini, *De glandulæ thyroideæ usu*; in the *Comm. Bonon.*, vol. vii., p. 15—23.—Lalouette, *Recherches anatomiques sur la glande thyroide*; in the *Mém. prés.*, vol. i. 1750, p. 159—175.—Gunz, *Obs. anat. I. sur la glande thyroide*, ibid., p. 283-284.—Schmidtmuller, *Ueber die Ausfuhrungsgange der Schilddrüse*, Landshut, 1804.—B. Hofrichter, *Mémoire sur la thyroide*, in the *Journ. compl. des sc. méd.*, vol. x., p. 21:

† Duvernoy, *loc. cit.*—Lalouette, *loc. cit.*, p. 163.—Morgagni, *Ex.* IX. *a.* 34.—Schmidtmuller, *loc. cit.*

‡ We have most generally found it, and Morgagni (*Ep. anat.* x. a. 36) has observed it to be absent only six times in a great many cadavers.

§ Schmidtmuller, *loc. cit.*, p. 29.

times it does not extend so high, and is inserted in the lower edge of the thyroid cartilage. In the latter case the middle horn is very slightly developed.

This muscle participates in the symmetrical arrangement of the middle horn of the thyroid gland, so that it generally belongs to the left half of this latter, more than to its right portion: it, however, is not always attached to the same side of the hyoid bone, or of the thyroid cartilage, but sometimes passes obliquely before the trachea or the larynx, to arrive at the opposite side. This arrangement, which apparently renders it still less symmetrical, although it really tends to re-establish the symmetry, occurs particularly when it is attached to the thyroid cartilage, and is then inserted in its inner edge, on the outside of the crico-thyroideus muscle.

§ 2329. Each of the lateral horns is generally two inches high, while the height of the isthmus is only one inch. The entire breadth of the gland is about eight inches; that of each horn is nine lines. The whole gland weighs about one ounce.

§ 2330. The thyroid gland is of a dirty red colour; its texture is firm and solid, its surface is smooth. It has no proper capsule, and is surrounded only by a condensed cellular tissue; it is composed of large and small rounded, irregular lobes, each enveloped by a cellular sheath, between which the vessels are distributed. It normally contains no cavity; however, when we make an incision, either into the lobes or between them, a fluid analogous to the serum of the blood, oozes in great abundance from the wound.

§ 2331. For a long time it has been disputed whether the thyroid gland has excretory ducts?

Several anatomists, as Vater,* Santorini,† Coschwitz,‡ and Schmidtmuller,|| have thought they saw one or more passages which extended from the gland into the larynx or trachea. They have attempted to consider the middle horn as an excretory canal, both from its form and the openings in the larynx on a level with its upper extremity. But the observations in support of this opinion are so trivial, and the most distinguished anatomists who have made them, have thought them of so little importance, that as yet we have reason to consider, with Duvernoy, Morgagni, and others, the thyroid gland as having no excretory passage, or none except the lymphatic vessels.

As the thyroid gland is proportionally much larger during the early periods of life, and as particularly its middle horn is then much more developed than in the adult, perhaps the excretory canal exists at this period, and is obliterated as the development of the gland is arrested, so that the imperfect development of the glands, from a deviation in formation, often results from the absence or obliteration of their excretory passages.

* *De nov. duct. saliv. in lingua humana*; in Haller, *Coll. diss.*, vol. i. p. 63

† *Loc. cit.*, p. 115.

‡ *Ductus salival. novus plurib. observ. illustr.*, Halle, 1729, p. 10.

|| *Loc. cit.*, p. 45-51.

B. DIFFERENCES RELATIVE TO SEX.

§ 2332. The thyroid gland is more developed in the female than in the male, which constitutes a very remarkable sexual difference.

C. DIFFERENCES DEPENDENT ON DEVELOPMENT.

§ 2333. The thyroid gland is at first formed of two separate glands, one of which is much larger proportionally than it is when the body is entirely developed, softer, more vascular, and consequently redder. Its middle horn, particularly, is much larger than it is subsequently.

D. ABNORMAL STATE.

§ 2334. The thyroid gland is sometimes, but very rarely, as Morgagni has remarked,* divided into two distinct and separate halves. This anomaly is very remarkable on account of its relations with the state of the organ in the early periods of fœtal existence, and because it occurs normally in most mammalia. An arrangement resembling it, is the considerable narrowness of the central portion or of the isthmus. Sometimes only a portion of a lobe is separated from the rest of the gland.†

Rather a common deviation of formation, but which is most generally consecutive, and rarely congenital, is the enlargement of the thyroid gland, which constitutes *goitre* (*struma*); this is frequently enormous, and is endemic in the narrow valleys of mountainous countries. The goitre, however, by no means always depends simply on an increase in the size of the thyroid gland: it is frequently only a consequence of the development of new formations in the tissue of this organ, or at least presents a complication of the two states.

Hypertrophy of the thyroid gland, when not endemic, is much more frequent in females than in males. It appears particularly at puberty,‡ gestation, parturition, and lying-in.

The abnormal formations occurring in the thyroid gland, are principally repetitions of normal organic elements, as serous cysts filled with different fluids, also cartilages, fibro-cartilages, and bones: all these formations frequently coexist.

§ 2835. From what precedes, it follows, as we have already remarked, that in its situation and form, the thyroid gland is a repetition, in the upper half of the body, of the uterus and prostate gland.

* *Ep.* IX. *a.* 30.

† Haller, *El. physiol.*, vol. iii. p. 396.

‡ *Journal de medecine de Sédillot*, vol. lvii., p. 416. We there read the remarkable case of a boy fourteen years old, in whom the thyroid gland was so much swelled, without any external cause, as to produce suffocation.

This analogy seems to us more just, because we frequently remark the same anomalies in both these parts at the same time in the same subject.

II. THYMUS GLAND.

A. NORMAL STATE.

§ 2336. The *thymus* gland (*Gl. thymus*, s. *corpus thymianium*)* is an irregular square or quadrilateral body, the base of which looks downward, and the summit upward, which occupies the upper and anterior part of the anterior mediastinum, where it is situated directly behind the sternum, before the base of the heart and the large vessels. It ascends also more or less out of the chest for about half an inch, and extends on the anterior face of the neck, where it is covered by the sterno-hyoidei and sterno-thyroidei muscles.

Its height and breadth much exceed its thickness.

Its length generally exceeds its breadth. Although it gradually contracts towards its summit, it however generally presents a more or less considerable prominence at its upper extremity.

§ 2337. Its colour is reddish white, and it is soft.

Its vessels, which are not very large, arise anteriorly, enter it from above downward, from behind forward, and from before backward. But each of its lobes has not a special trunk, and receives vessels from several regions at once.

§ 2338. Beside an external envelop, which is given to it by the anterior mediastinum, the thymus gland has still a less dense or less solid proper cellular capsule, below which the fat collects here and there in corpulent persons, but does not accumulate in any great quantity.

After removing this capsule, the thymus gland is itself divided into a right and a left half. Its two lateral lobes are attached only by very loose cellular tissue, and by the vessels which penetrate them, so that it would be more correct to admit two thymus glands.

These two halves, which are also triangular, and the two internal faces, are situated one against another in their whole extent, are similar in form and volume, but not exactly alike : one of them is sometimes about one-tenth larger and heavier than the other.

The external envelop of the thymus gland will show that its surface is not smooth and uniform, but divided into several larger and smaller lobes, which are composed of smaller lobules, separated less deeply from each other, between which the two external envelops do not

* G. B. Metzger, *Hist. anat. med. thymi*, Tubingen, 1679.—G. H. Muller, *De glandula thymio*, Leyden, 1705—Verheyen, *De thymo*, Leyden, 1706.—G. Bidloo, *Defens. exer., de thymo*, Leyden, 1707.—J. G. Duvernoy, in the *Com. Petrop.*, vol. vii.—A. L. de Hugo. *De glandulis et specialim de thymo*, Gottingen, 1746 —G. Hewson, *Experimental inquiries*, part iii London, 1717.—Lucæ, *Anatomische Untersuchungen der Thymus in Menschen und Thieren*, Frankfort, 1811-12.

penetrate more than between the two great lateral lobes, and which are united only by a loose cellular tissue and by vessels.

§ 2339. On cutting the thymus gland, there flows out spontaneously, or by pressure, a fluid, differing from its own substance, more or less abundant, thick and whitish, similar to that which exists in the ruminantia, between the fœtal and maternal portions of the placenta.

Opinions differ in regard to the relations between this liquid and the substance of the organ. With this question is connected another: Is the thymus gland hollow?

Many anatomists assert there is no cavity in the gland, and this fluid is consequently contained in its substance. Others think that the lobules alone are really hollow. Finally, some admit a great cavity the parietes of which are formed by the substance of the organ.

We maintain the latter opinion: for in examining very recent thymus glands, we have several times observed either on cutting them or slightly inflating them, a large cavity in each of the two lateral lobes. This cavity is lined by a thin and smooth membrane. It communicates with those in the lobules, and contains a great quantity of the fluid mentioned above.

Sometimes, however, this cavity is less apparent, so that very possibly the internal arrangement of the thymus gland is not always perfectly the same. Thus, in some cases, the lateral cavities are divided into several compartments by intermediate septa. Sometimes, however, we find the arrangement maintained by the partisans of the second opinion to be constant, and to which the preceding imperceptibly leads.

§ 2340. The thymus gland does not continue to exist during life.

It is first seen in the third month of gestation.

It is at first proportionally smaller than at a more advanced period, and its proportional size increases till the moment of birth.

In the full-grown fœtus it weighs half an ounce, and sometimes a drachm more when the child is vigorous and strong.

Its upper part appears first, and it enlarges from above downward.

Although it is not proportionally as large until the end of the first year, and sometimes even till that of the second, it continues to grow during all this period in the same proportion as in the full grown fœtus.

But at this period it wastes, its vessels contract and the fluid it secretes diminishes. It disappears in a direction opposite to that in which it was formed, that is from below upward.

At twelve years of age we find no trace of it, and it is then replaced by fat.

From this we may conclude that it does not exist except for about the fifth part of life, and that the energy of its function declines long before it disappears. Its most flourishing period is consequently very different from that at which most other organs have attained their greatest development.

§ 2311. We have already mentioned in a general manner its functions: several circumstances lead us to think it is very intimately connected with respiration, and more or less replaces it. We may, however, easily reconcile the two conjectures, since from what we have said above, the use of the thymus gland is to prepare for the perfect formation of the blood by respiration.

B. ABNORMAL STATE.

§ 2312. The greatest anomaly of the thymus gland is its *absence*, which is generally observed in acephalia vera.

Its *smallness*, when the organ is perfectly developed in respect to the number of its parts, is commonly attended with a languid state in nutrition generally. We have sometimes seen this anomaly also in acephalia falsa.

The thymus gland is rarely in this case divided into several, even as many as five lobes.*

Its continuance at the degree of development which characterizes it in the early periods of life, sometimes attends abnormal formations of the heart, and those states of the lungs which prevent the perfect formation of the blood.† This then supports our opinion advanced above in regard to its functions.

As this organ disappears very early, alterations in its texture are proportionally rare. We may, however, mention as such, different kinds of tumors, although in many cases those mentioned by authors are developed only in the place occupied by the thymus gland, and after it has disappeared.

CHAPTER III.

OF THE URINARY SYSTEM AND RENAL CAPSULES.

ARTICLE FIRST.

URINARY SYSTEM.

PERFECT STATE.

§ 2313. The *urinary organs* (*organa uropoetica*)‡ are composed of four parts, destined to secrete, carry, preserve, and excrete the urine,

* Meckel, *Handbuch der pathologischen Anatomie*, vol. i. p. 488.
† Meckel, *Abhandlungen*, p. 234.
‡ G. Bendt, *De fabrica et usu viscerum uropoeticorum*, Leyden, 1744.—J. Fantoni, *De renibus et primum de succenturiatis. de ureteribus et vesica*, Turin, 1745.
—A. Richerand, *Mémoire sur l'appareil urinaire*; in the *Mem. de la soc. méd. d'emul.* vol. iv. p. 303.

viz. the *kidneys*, the *ureters*, the *bladder*, and the *urethra*. The last three organs may be opposed to the first. These are entirely excretory organs, for they carry nothing which can be useful to the organism, remove from the body an excess of azote, which is the base of the most essential constituent principle of the urine, the *urea*, and correspond in form and situation in the lower half of the body to the respiratory organs in the upper.

I. KIDNEYS.

A. NUMBER AND SITUATION.

§ 2344. The *kidneys* (*renes*),* the most essential part of the urinary apparatus, are double in the normal state, a right and a left; they are entirely distinct from each other, having no communication in substance, and connected in one system only by means of the bladder. They are situated in the lumbar region, on the two sides of the vertebral column, behind the peritoneum, and are connected with the adjacent parts only by loose cellular tissue.

B. FORM.

§ 2345. They have the form of a bean. Their anterior and posterior faces are smooth. Their external and internal edges are convex in the upper and lower parts, but in their centres is a considerable depression, termed the *fissure of the kidney* (*hilus renalis*). The kidney is divided in this part, for about half an inch, into an anterior and a posterior half, between which pass the excretory duct and the blood-vessels. The blood-vessels are arranged so that the venous trunk is situated before, and followed by that of the artery behind which the ureter commences.

The branches of the renal artery and vein intercross.

When the three vessels have arrived at the fissure of the kidney, they divide near the inner edge of the gland into three principal branches, which soon ramify. The blood-vessels then divide into two series, an anterior and a posterior, which receive the vessels of the pelvis.

* B Eustachi, *De renibus libellus*, Venice, 513.—J. Lœsel, *Scrutinium renum*, Konigsberg, 1612.—M. Malpighi, *De renibus, in ex. de viscerum structura*.—L. Bellini, *De structura renum*, Florence, 1662.—Bertin, *Mémoire pour servir à l'histoire des reins*, in the *Mémoires de Paris*, 1745, p. 108.—A. Ferrein, *Sur la structure des viscères nommés glanduleux, et particulièrement sur celle des reins et du foie*; in the *Mém. de Paris*, 1749, p. 709.—J. F. Droysen, *De renibus et capsulis renalibus*, Gottingen, 1752.—A. Schumlanski, *De structura renum*, Strasburg, 1788.—C. G. Eysenhardt, *De structura renum observationes microscopicæ*, Berlin, 1818.—A. H. C Westrumb, *Comment. phys. de phænomenis quæ ad vias sic dictas lotii clandestinas demonstrandas referentur*, Gottingen, 1819.—Mappes, *Quelques considérations sur la structure du rein et du foie*; in the *Journ. compl. des sc. méd*, vol. xii, p. 223.

All these vessels are united in the fissure of the kidney only by a :ery loose cellular tissue and by fat.

Three particularly enter and emerge through the upper part of the enal fissure, the lower part of which is occupied by the pelvis.

C. VOLUME AND WEIGHT.

§ 2316. The proportional size of the kidneys vary. Generally hese organs are larger the nearer the fœtus is to its period of formaion: they however present, even under this point of view, individual ifferences, which are independent of the age, and which seem to reate to the size and energy of the other excretory organs.

Generally speaking, the two kidneys are equal in size: both, howver, frequently vary extremely, although the side of the body has no ffect upon it. The ancients asserted that the right kidney is always arger than the left, which is incorrect.

In the adult they are about four inches long and two broad. They re about an inch thick at their inner part, but are thinner outward.

Each of them weighs between three or four ounces.

D. CONSISTENCE AND COLOUR.

§ 2317. The kidneys are much harder than the other glands, and re firmer, more solid, and less easily torn.

They are generally reddish.

E. STRUCTURE.

§ 2318. They are surrounded by a very loose cellular tissue, most enerally abundantly provided with fat, and termed the *adipose memrane*, or *capsule of the kidney* (*mem. s. capsula renum adiposa*).

We find below this cellular mass a whitish membrane, reddish on s two faces, the texture of which is not evidently fibrous, but which very solid, and resembles the fibrous membranes. This capsule nvelops the entire kidney; it only presents an opening corresponding the fissure, for the passage of the blood-vessels and the excretory uct, and it adheres intimately in its whole extent to the substance rgan.

F. TEXTURE.

§ 2319. The kidneys are formed of two substances, which differ uch in colour, situation, consistence, and texture. They are the *cortiil* or *glandular* substance (*substantia corticalis, s. glandulosa,*) and e *medullary, tubular*, or *fibrous* substance (*s. medullaris, tubulosa, s. brosa*).

§ 2320. The cortical surrounds the medullary substance in most its extent, and in every direction. It not only forms entirely the

face of the kidney, but extends also to its inner face by several arched prolongations, between which the medullary substance is situated. It consequently forms a collection of cavities, united by a common base, the culs-de-sac of which are turned outward.

Thus the cortical substance forms the external and coloured part of the kidney; it is about two or three lines thick: its colour is redder than that of the medullary substance, and it is much less consistent.

It is composed principally of blood-vessels and glandular bodies, which are the organs of the urinary passages. The urine is secreted in it.

§ 2351. The medullary substance is inclosed in the preceding, and is composed of a mass of rounded, conical, or pyramidal bodies (*pyramides Malpighianæ*), the bases of which are turned outward, and the blunt summits inward; if we except the most internal part, which is only some lines high and broad, and which constitutes the *renal papillæ* (*papillæ renales*), it is entirely enveloped by medullary substance.

It opens in this place into the commencement of the ureter or pelvis.

The summit of the renal papillæ usually, but not always, presents a greater or less number of rounded openings, which, although small, are visible to the naked eye. The papillæ, which have a depression, present openings only in this groove, while in those which terminate simply in a point, the foramina are arranged around the summit.

The loose extremity of these papillæ is covered by thick envelops, which is continuous with the inner membrane of the pelvis.

The number of these papillæ varies, from seven to twenty. They are distributed in three series, a middle, an anterior, and a posterior, all of which are directed from above downward. Those of the inner series are turned inward towards the median line of the body: those of the anterior go backward, and those of the posterior forward, that is in a direction opposite to the preceding. The superior go downward in every direction.

Sometimes the papillæ, which are entirely distinct at their base, unite and blend at their summit.

The medullary substance is less red and much harder than the cortical.

It is composed of blood-vessels, but particularly of straight urinary passages, with which the foramina of the papillæ communicate.

The urine is secreted in it, as when it is compressed this fluid escapes from the excretory passages, which form most of it, through the foramina of the papillæ.

§ 2352. From this description it follows that the kidneys are composed of about fifteen segments, termed *lobules* (*lobuli renales, s. renculi*), each of which is formed in turn of medullary and of cortical substance, and the cortical envelops of which are continuous with each other.

§ 2353. The intimate structure of the kidneys is demonstrated by aceration, injection, and the microscope.

§ 2354. The surface of the cortical substance is not smooth, but eems formed by numerous irregular, rounded, quadrangular, pentanal, or hexagonal spaces, arranged very compactly, which are not alf a line in diameter. These spaces are confined by small vessels, hich send branches within them: they consequently have a ighter colour than that of their edges, which are formed by these essels.

We also find in every part in the cortical substance, rounded coruscles, appearing to the naked eye as very small points. These orpuscles depend on the most minute ramifications of the bloodessels, particularly the arteries, and in connection with them they ave the form of a bunch of grapes.

Some anatomists, especially Malpighi, Bertin, and Schumlansky, onsider them as special organs, different from the branches of the essels, as glands or bursæ, on the parietes of which the vessels are stributed. Farther, authors are not agreed in respect to them, for ertin has described and figured them much larger than those imitted by Malpighi, while the observations of Schumlansky, from hich those of Eysenhardt do not essentially differ, agree with the sertions of Malpighi. Others, as Ruysch, consider these corpuses not as glands, but as branches of vessels.

It is more probable that they are formed by the twigs of the teries, and by the roots of the excretory passages in the cortical bstances, united by a mucous tissue, and that they are not hollow. this manner the two opinions may be reconciled.

The urine is undoubtedly formed, at least in great part, in these orpuscles.

They seem not to have a special envelop, and they are formed, at ast generally, by a single arterial twig.

They are not seen to communicate distinctly with the veins, though the transition of them to the arteries is easily perceived.

§ 2355. Besides these glandular corpuscles, the vascular ramificaons to which we shall return hereafter, and finally the soft and itish tissue which unites all these parts, and to which Ferrein parularly has called the attention of anatomists, the cortical substance o includes numerous small, white, and very tortuous canals, called e *cortical canals*, or *ducts of Ferrein* (*C. corticales*). These passages equently anastomose together, usually proceed separately, somenes unite in pairs, and circumscribe small and infinitely varied aces. They compose most of the cortical substance, and are ry probably the excretory canals of the corpuscles above mennod.

The canals are tortuous in the cortical substance, but become aight in the medullary substance. When looked at attentively observe here and there that the change in direction regularly mmences rather high, some distance from the surface of the kidney,

so that the cylindrical prolongations of the medullary and the cortical substance reciprocally penetrate in numerous points.

The cortical canals are single, and always have the same diameter in the cortical substance; but they gradually unite in the medullary substance in the form of angles acute at the base, into several trunks, which generally are not much larger than they, and proceed side by side toward the summit of the papillæ; but according to some anatomists, particularly Ferrein and Eysenhardt, they do not extend to the openings in these papillæ, but terminate before arriving there. The same writers add that the openings of the papillæ only lead into small culs-de-sac about one or two lines deep, which like them are much broader than the canals of which we speak, and also fewer, there being according to Ferrein, twenty in each papilla.

We have sometimes seen very distinctly some canals which extended entirely through the renal papillæ, so that we admit a direct continuity between the urinary passages and the openings of the papillary eminences. We are more disposed to adopt this opinion, as it is very easy to inflate the passages through the papillæ, since in large animals even an injection passes from the artery into the whole papilla, and urine is passed out from it in compressing the cortical substance.

§ 2356. Each lobule of the kidneys then is composed of several masses of canals, which are at first tortuous, then straight, arranged very compactly, which have their base turned upward, their summit downward, but represent the form of the whole, and are only more elongated.

The right part of these canals, which is contained in the medullary substance, has long been known, for it is mentioned by Berenger de Carpi; but it is described most correctly by Berlin: hence they are termed the *ducts of Bellini* (*ductus*, s *tubuli Belliniani*, s. *renales*).

Until the time of Ferrein these canals, which are visible to the naked eye, were thought to be simple: but it follows from the researches of the anatomists and those of Schumlansky, that each is a fasciculus of several hundred passages, termed the *pyramid of Ferrein*.

Each tortuous canal is about one sixtieth of a line in diameter. The total length of all these passages collectively is, according to Ferrein's estimate, more than sixty thousand feet. There are in each lobule seven hundred pyramids, and hence as each kidney is composed of fifteen lobules, there are about ten thousand pyramids.

According to Eysenhardt's observations, each canal of the pyramids of Ferrein is composed of about twenty smaller ducts.*

But there is certainly much incorrectness and latitude in these assertions.

G. VESSELS.

§ 2357. The two series of vessels, after being arranged in the fissure of the kidney in the manner mentioned above, enter into the

* Eysenhardt, p. 12.

substance of the organ on a level with the base of the renal papillæ, and go from below upward in the prolongations sent inwardly by the cortical substance.

Their branches describe arches turned towards one another, which principally surround the bases of the pyramids of Ferrein or the different segments of the inner substance. Between these arches the anastomoses are but few and small. Although they follow the divisions of the medullary substance they are not distributed within it, but almost exclusively in the cortical substance, first in the segments between the papillæ, then in the outer layer of the kidney.

Numerous small branches radiate from the convexity of the largest; these surround the base of each lobule, and ramify more and more to give rise finally to glandular corpuscles. Many of these branches penetrate to the external face of the kidney: others do not extend so far.

The arteries and the veins reciprocally attend each other. Still, although the direct communication between these two orders of vessels is admitted and is easily observed, we are as yet unable to discover any between the most minute twigs of the veins and the glandular corpuscles, while these latter adhere very intimately to the ramifications of the arteries, with which they represent, as we have already mentioned, a bunch of grapes.

Numerous lymphatics arise from the kidneys, but they represent nothing peculiar in the direction of their vessels.

II. NERVES.

§ 2358. The nerves of the kidney are proportionally very small, they arise from the renal plexus of the great sympathetic nerve, are situated on the surface of the arteries, but do not penetrate deeply into the organ.

II. URETER.

§ 2359. The *ureter** commences at the fissure of the kidney by several rounded canals, the *calices*, which embrace the papillæ, and terminate suddenly or rather become thinner rapidly at their bases, and are continuous with their external membrane.

The number of calices generally but not always equals that of the papillæ. Sometimes a calix divided only into two compartments by a slight prominence embraces two papillæ, which are then near each other, a structure which leads to the union of two of these prolongations in one.

The others generally contract in two large trunks, a superior and an inferior, which are termed the *branches of the pelvis*. The superior

* Pohl, *Obs. de ureteribus*, Leipsic, 1772.

trunk is generally larger and composed of two branches. The two trunks are united by a narrower intermediate canal, which descends longitudinally.

The pelvis, which gradually terminates in a point from above downward, on a level with the lower extremity of the fissure of the kidney, is as small as the ureter.

The ureter is about two lines broad and a little tortuous; it is surrounded by a very loose cellular tissue, and descends on the psoas muscle behind the posterior wall of the peritoneum. It crosses the spermatic vessels, situated before it and above the primitive iliac artery, to enter into the pelvis: it then approaches that of the opposite side, being about an inch and a half distant from it, and arrives at the lower and posterior part of the bladder. After proceeding three or four lines between the fibres of its muscular tunic, forming a prominence directed from above downward and from without inward, it opens by an orifice which is slightly narrower, having the same direction, but no valve.

§ 2360. The ureter is formed of two superimposed layers. The external is composed of a compact cellular tissue. It has a fibrous appearance, but no muscular fibres. The internal is a thin and smooth mucous membrane, which is continuous above with that of the renal papillæ, below with that of the bladder.

This canal has no valves.*

III. BLADDER.

§ 2361. The *bladder* † (*vesica urinaria*) is an elongated rounded reservoir, the length of which exceeds its breadth and thickness; it is situated in the cavity of the pelvis, behind the symphysis pubis, on the outside of the peritoneum, before the rectum in the male and the vagina in the female, and is surrounded by a very loose cellular tissue.‡

* Coschwitz, *De valvulis ureterum*, Halle, 1723.

† J. Parsons, *Description of the human urinary bladder and the parts belonging to it*, London, 1742.—A. F. Walter, *De collo vesicæ virilis*, Leipsic, 1745.—J. Lieutaud, *Observ. anat. sur la structure de la vessie*; in the *Mém. de Paris*, 1753.—J. Van Beekhoven de Wind, *Diss. de ureteribus et vesicá urinariá*, Leyden, 1784.

‡ As the recto-vesical operation for stone, which becomes more advantageously known every day, requires a very exact knowledge of the anatomical relations of the bladder, we shall quote here the description of it by Sanson. (*Des moyens de parvenir à la vessie par le rectum*, Paris, 1817, p. 15.) The base of the bladder is extended from behind forward, from the recto-vesical layer of the peritoneum to the origin of the urethra, is continuous on the sides with the lateral regions of the organ, although there is no very distinct line of demarkation between them, and its dimensions are nearly equal in every direction: it is united by firm adhesions to the ureters, the vasa deferentia and the vesiculæ seminales, which passing through it obliquely from behind forward and from without inward, thus divide it into three surfaces, two of which are lateral, convex, broader anteriorly than posteriorly, situated on the outside of the seminal vesicles, and correspond to an abundant and fatty cellular tissue, which separates them from the levatores ani muscles, while the third, the central, exists between the testicles, is triangular,

We distinguish in the bladder an upper and rounded part, termed ɩe *base* (*fundus*), a central part, the *body*, and an inferior part, the *eck* ((*cervix* s. *collum vesicæ urinariæ*).

We must regard it as an excessive common dilatation of the reters, which curves from below upward on leaving the lower extreity of these two passages.

It is continuous at its lower extremity with the *urethra*, at the pper with the *urachus*, a kind of ligament which proceeds towards ae umbilicus along the anterior wall of the anterior face of the eritoneum, gradually becoming thinner.

§ 2362. The bladder is composed in its whole extent of three supernposed layers: but in the upper part of its posterior face there are our.

The fourth layer is the most external, and covers the organ only 1 the place mentioned; it is the anterior part of the inferior wall of ie peritoneum.

This membrane, which adheres to the subjacent muscular tunic y a very loose cellular tissue, is reflected from the bladder on the pper part of the anterior face of the uterus. The rest and largest art of the bladder is covered only by a very loose layer of cellular issue, which unites it to the adjacent organs.

aving a base which looks backward, and corresponds to the peritoneum, and a immit turned forward, which looks to the prostate gland and rests directly on ie centre of the rectum, and follows its curve exactly to the gland. It is there eparated from it, and goes obliquely from behind forward and a little from below pward to the neck of the bladder, where it blends with the origin of the urethra, hich may be regarded in some measure as its continuation. This latter, the rigin of which is embraced by the prostate gland and blended with the neck of ie bladder, is not by any means so near the symphysis pubis as has hitherto een believed, since, placed upon a line which would extend from the lower part f this symphysis to the summit of the coccyx, it is about two inches distant om it, first passes through the prostate gland, approaching the rectum a ttle, then becoming loose goes directly towards the root of the penis, entering it elow the arch of the pubis, from which it is about fifteen lines distant; at the ime time it is about fifteen lines distant from the intestine, with which it forms n angle open towards the perineum. The skin of this region and the prolonation of the sphincter downward, the urethra forward, and the last portion of the ectum provided with this same sphincter posteriorly, form the three sides of a tringular space filled by fatty cellular tissue, the base of which corresponds to the aphe, and at the summit of which is the prostate gland. If, taking the cavity of ie rectum for a point of departure, we examine the parts before the intestine in ie order in which they appear, following the median line of the body, we find: st, on leaving the central portion, and proceeding obliquely from behind forward nd from below upward, the anterior wall of this portion, a more or less dense ayer of loose cellular tissue containing a net-work of small veins, the lower wall f the bladder and its cavity; 2nd, on leaving the curve formed by the intestine elow this region to go towards the anus, and following a more horizontal direcion: the anterior wall of the rectum, a thin compact layer of cellular tissue, the rostate gland perforated by the part of the urethra where we remark the crest of he urethra and the orifices of the vasa deferentia; 3rd, finally, on leaving the owest part of the intestine, and following a horizontal line from before backvard, the anterior wall of the rectum united to the sphincter, the triangular space ientioned above, and entirely forward, the bulb of the urethra and the posterior art of the bulbo-cavernosus muscle. In following this direction, proceeding rom any point whatever, we open no vessels, except the capillary anastomoses vhich establish the communication between the two sides of the vascular ystem. F. T.

The texture of the muscular membrane is very complex: it may, however, generally be reduced to two superimposed layers, which, however, interlace at intervals.

The external layer, the strongest and most compact, is formed of longitudinal fibres; these fibres ascend from the lower extremity of the anterior and posterior faces of the bladder toward the base of the organ, where they partly anastomose with each other, and partly also go from within outward.

The posterior external fibres are reflected from above downward some lines below the urethra, go thence forward and upward, and are then continuous, from without inward, with the anterior longitudinal layer.

The lateral faces are mostly destitute of longitudinal fibres.

The internal layer is formed almost entirely of oblique fibres which proceed in opposite directions, so that they frequently intercross and interlace together.

The inferior are entirely transverse, and are more compact. They form the *sphincter of the bladder* (*M. sphincter vesicæ urinariæ*).

The others are more remote from each other, and represent a network, through the meshes of which we observe the inner membranes when the bladder is distended.

Below this second layer we find in several parts, but principally downward, some thinner muscular fibres arranged longitudinally, which form in this place a third layer.

§ 2363. Next to the muscular tunic come the vascular membrane, which is very thin, and the mucous membrane. The latter is apparently smooth, or at least its villosities are very minute. There are generally no muciparous glands visible on its posterior face, except at the neck of the bladder; these glands, however, may sometimes be seen when morbidly enlarged.

§ 2364. The internal face of the bladder is smooth in nearly its whole extent, except some inconstant prominences, which are often produced by the internal muscular layer.

The posterior face of the neck, however, presents an eminence which leaves the orifice of each ureter, is directed downward and inward, unites below at an obtuse angle with that of the opposite side, on the median line, and thus gives rise to an angle projecting downward, termed the *trigonus of the bladder* or *of Lieutaud*.

This eminence is formed by some fasciculi of the internal muscular fibres, which are more numerous in this part, the upper extremities of which are attached around the orifices of the ureters, and which in contracting extend and consequently enlarge these orifices, and thus facilitate the flow of urine into the bladder.*

* C. Bell, *Account of the muscles of the ureters and their effects in the irritable tate of the bladder*; in the *Med. chir. trans.*, vol. iii., p. 171—191.

IV. URACHUS.

§ 2365. The *urachus** is an elongated, very thin cord, which is entirely enveloped by the peritoneum; it gradually becomes thin from below upward, is attached directly to the anterior wall of the abdominal cavity, and goes from the base of the bladder towards the umbilicus, but frequently does not extend as high. Its fibres are more or less distinctly continuous with those of the muscular membrane of the bladder.

Its texture is very differently stated by anatomists. Their descriptions vary, particularly as some admit that it is hollow in the adult, while others deny it.

Walter asserts it is hollow;† Noreen, Senac,‡ and Portal, on the contrary, think it is full and solid.

The latter writers assert that this cord is composed, beside its peritoneal tunic, of four layers, intimately united at its upper part, that is, in most of its extent; they separate near the summit of the bladder, and, in passing under its muscular membrane, go, two on the sides, the other two on the anterior and posterior faces of the bladder to its neck. They add that these two layers unite with each other and with the peritoneal coat more intimately as age advances.

Walter, on the contrary, states the urachus to be formed externally by longitudinal and then by circular fibres, and after that by the vascular and muscular membranes of the bladder. We may introduce into it for some inches a sound and mercury, but it terminates at the side of the umbilicus in a cul-de-sac, and often contains a reddish fluid.

From our observations it follows that generally the urachus is completely obliterated when the body is perfectly developed, and often even long before this period, and thus it is then changed into a perfectly homogeneous cord, although we have often seen the arrangement mentioned by Walter.

Finally, Noreen and Portal themselves mention several instances of this structure, which Noreen has figured very exactly.

* J. C. Peyer, *Observat. circa urachum*, Leyden, 1721.—J. Noreen, *De mutatione luminum in vasis hominis nascentis, in specie de uracho*, Gottingen, 1749.—P. A. Boehmer, *De uracho in adulto homine aperto*, [*cum ejusd. anat. ovi hum.*, Halle, 1763.—A. Portal, *Sur la structure et sur l'usage de l'ouraque dans l'homme*; in the *Mém. de Paris*, 1769, p. 19.

† *Obs. anat.* Berlin, 1775, p. 19.

‡ *Essais de physique*; in Portal, *Mém. sur plus. maladies*, vol. i.

V. URETHRA.

§ 2366. The *urethra*,* the termination of the urinary system, is a canal narrow in proportion to the bladder, which is continuous by its inner extremity, the *vesical* orifice, with the neck of the bladder, and by its outer extremity, the *cutaneous* orifice, with the common integuments. It is composed in both sexes of a mucous membrane covered with a loose and spungy cellular tissue, and a very complex vascular net-work. It is much shorter in the female than in the male, being about two inches long in the former and eight in the latter. The urethra in the female, on the contrary, is much broader than in the male.

In both sexes this canal is situated below the organs of pleasure, that is, in the female below the clitoris, and in the male below the corpus cavernosum of the penis, which latter it contributes to form.

From the different length of these parts it does not open at the same place in the two sexes. In fact in females its external orifice is situated directly before the entrance of the vagina, and between the external labia; in males at the anterior extremity of the penis. As in the male it is also the excretory canal of the semen, it will be more convenient to describe its texture when treating of the genital organs.

B. FUNCTIONS OF THE URINARY ORGANS.

§ 2367. The function of the urinary organs is to secrete and to excrete the *urine* (*urina, lotium*).

The physical qualities of this liquid are its yellowness, tenuity, transparence, slight viscosity, and particularly its peculiar odour.

The urine is composed of numerous constituent parts, which vary more in their proportions than number and nature, at different periods, than in any other animal liquid.

One of the principal characters of its chemical composition consists in the great quantity of water it contains, which forms at least nine tenths of it.

The substances which in the normal state are always or most generally dissolved in the water, are:

1st. *Urea*, which of all the animal substances possesses the most azote, as it contains thirty-two per cent. according to Fourcroy and Vauquelin; forty-three per cent. according to Berard; and even forty-six per cent. according to Prout, while there is only about twenty per cent. in the fibrine.

2nd. An animal substance insoluble in alcohol.

* A. Moreschi, *Commentarium de urethræ corporis glandisque structura*, Milan, 1817.—Amussat. *Remarques sur l'urèthre de l'homme, et de la femme*; in the *Archiv. gén. de méd.*, vol. iv., p. 31 and 547.—E. Home, *Mém. sur la structure de l'urèthre, d'après les observations microscopiques*; same journal, vol. ii. p. 140.—T. Ducamp, *Traité des rétentions d'urine*, Paris, 1822, p. 1.

3rd. Several acids, the uric* and the lactic.

4th. Several salts, viz. the lactate of ammonia, sulphate of potash, sulphate of soda, phosphate of soda, hydrochlorate of ammonia, and the earthy phosphates, with some fluate of lime.

5th. A little of silex.†

Besides these substances, which enter regularly into the urine, we sometimes recognize by our senses several constituent principles of the body introduced into the system in different modes. Thus, for instance, rhubarb colours it a deep yellow, and asparagus communicates to it a disagreeble odour.

Although these substances also occur in greater or less quantity in the other excretory fluids, especially in those exhaled by the lungs and the skin, and in the matters expelled directly from the intestinal canal, they nevertheless occur more frequently in the urine, so that the urinary system seems to be the principal excretory organ of those materials which cannot be assimilated. It necessarily exercises a peculiar attraction for these substances, in order to remove them from the blood and fulfil its function.

This system is also the principal agent of purifying it in the morbid state: thus the urine is more or less modified in all diseases generally.

§ 2368. But the urine constantly presents differences also in regard to the greater or less length of time which has elapsed between its emission and taking food or drink. Upon this is founded the distinction between the *urine of the drink*, and the *urine of digestion* or *of the blood*. But it must be admitted that these differences are very slight.

The urine of the drink, which is voided directly after a meal, is very watery and limped. The urine of digestion, voided some hours after eating, during the digestive process, is more coloured, less watery, more odorous, and usually presents the smell and taste of some of the articles of food. Finally, that which is passed when digestion is finished, the proper and perfect urine, is more highly coloured, and less in quantity: it has not the characters of the ingesta, but, on the contrary, presents the characteristic smell and taste of the urine.

From comparative experiments, the urine of the food contains only one-thirteenth of urea, one-sixteenth of uric acid, and one-fourth of the salts found in the urine of digestion or of the blood.

§ 2369. For a long time the question has been discussed, and it is not yet settled, whether the constituent materials of the urine are carried to the urinary system only by the vascular system, or whether they do not proceed there directly by a shorter route, and conse-

* It seems probable, from Prout's experiments, that pure uric acid does not exist in the urine, but it is combined with ammonia. Lactic acid is then the only cause of the acidity of the urine in the normal state. F. T.

† Berzelius, *Annales de chimie*, vol. lxxxix., p. 22.

quently, whether there are not *secret urinary passages* (*viæ urinariæ clandestinæ*).

The arguments in favour of the existence of these passages, are:*

1st. The rapidity with which fluids, especially cold water, are expelled with the urine, and particularly the great quantity of fluids evacuated in a short time through this passage, whether these liquids have been introduced into the intestinal canal, or injected into the cavity of the abdomen.

2nd. The passage of several substances through the urine unchanged, instances of which we mentioned above.

3rd. The presence in the urine or in the lymphatic vessels, between the mesentery and the urinary system, of these substances, or of other materials formed even in the body, as the saccharine matter in diabetes, although the blood contains no trace of them.

4th. The presence of urine in the bladder, although the kidneys have been destroyed, the ureters tied, and even when the kidneys did not exist, or at least they did not communicate with the ureters.

5th. The presence in the bladder of solid bodies introduced into the body by swallowing or any other mode.

6th. The very active sympathy between the bladder and the stomach.

The manner in which the substances contained in the urine can arrive at the urinary system without passing through the vessels, has been explained in several different ways.

1st. Some think there are no visible channels, but that the phenomena depend simply on transudation through the adjacent parts, paticularly from the intestinal canal into the bladder, through the medium of the mucous tissue†.

2nd. Others admit a retrograde motion in the lymphatic vessels and urinary system, and even support their opinion by those cases where the valves of these vessels have an opposite direction, and are turned from the heart.

3rd. Finally, some admit special canals, situated between the stomach and the urinary apparatus.

§ 2370. But it is easy to refute all these arguments and the manner in which they are explained.‡

Nothing can be concluded from the last two arguments, for the sympathy between the stomach and the urinary system does not depend on mechanical connections between them, and solid bodies

* C. G. Kratzenstein, *Theoria fluxus diabetici ejusque sanandi methodus*, Halle, 1746.—Darwin, *Zoonomie*, vol. i.—Wollaston, in the *Phil. trans.* 1811.—Treviranus, *Biologie*, vol. iv., p. 513-521.—Morichini, in the *Mem. della soc. ital.*, vol. xvii.—Tiedemann and Gmelin, *Recherches sur la route que prennent diverses substances pour passer de l'estomac et du canal intestinal dans le sang, sur la fonction de la rate et sur les voies cachées de l'urine*, Paris, 1821.

† Treviranus, *Biologie*, vol. iv., p. 513-521.

‡ P. J. Hartmenn, *Super urinæ diâpedes quæstiones*. Utrecht, 1776.—G. G. Erhardt, *De secretione lotii unica et sufficiente*, Erfort, 1799.—J. Jacopi. *Esame della doctrina di Darwin sul moto retrogrado del liquid nei vasi linfatici*, Pavia, 1804.

enetrate through unusual channels formed by these bodies from the ompression they exercise.

In order to refute the fourth argument, it is sufficient to remark hat we do not in fact find urine in the bladder when the kidneys ave been entirely destroyed, that a portion of the kidney still re- nains where they seem to have been entirely destroyed, that no urine ollects in the bladder after tying the ureters, if the bladder be ntirely emptied; and finally, that the cases of a noncommunication etween the ureters and the kidneys are very doubtful.

To the third argument we may answer, that at least all the imme- liate principles of the animal substances do not exist in the blood; hose found there do not exactly resemble those in the body, since he same substances occur in other parts of the body, from whence it s not proved that they pass into the urinary system: that very pos- ibly the substances proved to exist in the urine, might have dis- ppeared from the blood or were concealed in some mode: that these ubstances have not been looked for in the arterial, but in the venous lood: finally, that according to Magendie, we may prove the exist- nce of one of these substances, the hydrocyanate of potass, in the rine, in any quantity however small, while after mixing it with the lood, even out of the body, we cannot detect it, even when in great uantity, by chemical re-agents.

Besides the simultaneous existence of several substances, as rhu- arb, has been proved in the serum of the blood and the urine.*

Treviranus asserts† that this phenomena proves nothing, as the erum of the blood contained less rhubarb than the urine. But it is asy to refute this objection, as the rhubarb is distributed through the hole mass of the serum, and could only be removed from it by the rinary system.

The lymphatic vessels, situated near the mesentery, may either ave sent these substances into the urinary system, and have acci- entally imparted to them a retrogade motion, contrary to that which ie fluids generally follow, although we have no right to conclude iat foreign substances always enter the urinary system through this nannel, nor even, by admitting the retrogade motion, that they were ntroduced by it.

The facts alleged in support of the second argument, do not com- ibute in manner to the explanation given of them. The formation nd the want of decomposition in certain substances would not be cplained more easily by this theory: for even admitting this chan- el, which is not much shorter, they are no less subject to the organic tion: but Davy's observations prove, that under the influence of ectricity, bodies may be separated contrary to the laws of chemical finity, and carried far by the fluids, without combining with other

* Home, in the *Phil. trans.*, 1808.
† *Biologie*, vol. iv., p. 520.

substances which these fluids contain, and which have great affinity for them.

Finally, in regard to the first argument, the rapidity with which drinks and certain substances pass into the urinary system, is not in fact as great as has been asserted, and may be easily explained by the short distance they proceed, even admitting that they are carried there by the blood.

If we find rhubarb in the urine in seventeen minutes, if it disappears from this liquid at the end of some hours, if it colours the excrement after six or seven hours, and is then found again in the urine, this fact does not prove as Treviranus asserts,* that the rhubarb, first found, has arrived at the urinary system by a shorter route than that afterward observed.

The rhubarb which appears first in the urine, has undoubtedly passed from the stomach, to the inner and absorbing face of which it was presented, without being decomposed into the sanguineous system, and seventeen minutes is not too short for the latter to come to the urinary system. The action of the rhubarb on the inner face of the stomach and intestinal canal, gradually causes the mucous membrane of these organs to a greater secretion, which surrounds them on every part and diminishes absorption. When this excessive action abates, the rhubarb is again absorbed. But there is another cause to which we must probably attribute the disappearence of the rhubarb in the urine during a certain length of time, viz. that the action of the kidneys is less energetic, while that of the alimentary canal is increased.

§ 2371. In regard to the passages, we may say:

1st. The opinion that the cellular tissue serves as a conductor, is very improbable, first, because the application of phenomena observed in the inferior animals, to the theory of those which occur in the superior animals, leads only to uncertain results, since by admitting this supposition, it is difficult to explain why the passage takes place through the kidneys.

2nd. The retrograde motion in the lymphatic vessels is very improbable, at least in the normal state, on account of the existence of valves. The cases where it is asserted the valves were found arranged contrary to what they are generally, are only exceptions, or at least are not sufficiently proved. Farther, this arrangement could not be general, since then there could be no absorption from the bladder. It is not proved that these valves are arranged in one manner in certain lymphatics, and an opposite manner in others.

3rd. The special canals have never been proved by authentic observations, and the passages considered as such, were evidently accidental and morbid formations.

4th. Finally, another circumstance prevents its admission, viz., that we have never found between the digestive canal and the urinary

* *Biologie*, vol. iv. p. 519.

assages, any substance in these two systems not contained in the anguineous system, and even when this phenomenon occurs, it can lways be explained by saying that the substances in this place, specially in the lymphatic vessels, have come there from the urinary ystem.

C. SEXUAL DIFFERENCES.

§ 2372. The urinary system, except the bladder and the urethra, resents no considerable differences relative to sex.

The bladder is rounder, broader, and generally larger in the female han in the male, where it is more elongated.

The urethra of the female is broader and shorter than that of the ale, representing in fact only its commencement.

D. DIFFERENCES DEPENDENT ON DEVELOPMENT.

§ 2373. This system changes much during life, in form, texture, oportional size, and situation.

I. KIDNEYS.

2374. 1st. The kidneys are much larger proportionally the younger fœtus is: in the full-grown fœtus their weight is to that of the ole body as 1 : 80, while the proportion in the adult is as 1 : 240. 2nd. In respect to form they are more elongated, and the pelvis is rer the anterior face, so that the renal fissure is less developed. eir surface is not smooth; they do not form a coherent and homoeous mass, but are composed of several lobules, which are at first tinct, but are united so as to produce the larger lobes, which are y evident in the abult, where, however, they are not separated. this period of life, in fact, they are attached only by a very loose lular tissue, so that they are easily insulated, and their bases are n marked on the surface of the kidney by considerable depressions. rd. The medullary substance is more abundant in proportion to cortical substance, than in the adult, at least in the full grown us. The fasciculi of the urinary passages, or the pyramids of rein, are separated from one another more easily, and like all ts of the body, are evidently composed of globules, which are not in the adult: on the contrary, the passages are more difficult to listinguished. Here then, also, as in the muscles and the lungs, large parts are formed before the small.

II. URETERS.

§ 2375. The ureters are also broader, proportionally, than when the subject is perfectly developed.

III. BLADDER.

§ 2376. From the narrowness of the pelvis, the bladder is not contained in this cavity; it is then situated much higher than in the adult, so that the urethra is proportionally very much longer.

It is much smaller before than after birth.

Its form is more elongated. This circumstance and its smallness, cause it to appear as a simple filament, and it seems to be only a slight dilatation of the urachus.

IV. URACHUS.

§ 2377. The urachus is much larger the younger the person is; it gradually diminishes, until in the course of life it often entirely disappears.

It is at first hollow, and according to our observations, it retains this character in the full-grown fœtus. At this period we can distinguish in it all the constituent membranes of the bladder with which its cavity communicates. This cavity is at first much larger proportionally, the younger the fœtus is. In the full-grown fœtus, and still more at the periods preceding birth, we can follow the urachus a greater or less distance, but always several inches beyond the opening of the umbilicus, sometimes even the whole extent of the cord. Analogy with animals, and several observations upon man, authorize us to think that it passes at first entirely through the umbilical cord, and dilates between the envelops of the fœtus, to give origin to a membranous vesicle, the *allantosi*, to which we shall return when describing the human ovum. This cord is certainly hollow, for even in the full-grown fœtus we have injected it with mercury through the bladder, and the injection extended more or less in the umbilical cord. Our observations on this subject agree with those of Rœderer* and Noreén.†

Several of the ancient anatomists, and even Trew, among the moderns,‡ have admitted that the urachus is full and solid in the fœtus, as it normally is in the adult. This erroneous opinion depends upon a great inflexion in the canal near its lower extremity; hence, when the bladder is distended, the muscular fibres are so adapted to its sides, that the opening by which they communicate is closed.

* *De fœtu perfecto*, Halle, 1759.
† *Loc. cit.*, p, 13.
‡ *De diff. inter. hom. natum et nascendum*, p. 104.

ARTICLE SECOND.

URINARY SYSTEM IN THE ABNORMAL STATE.

§ 2378. The urinary system is one of those anomalies which occur most frequently,* particularly as respects those of formation, for the most striking differences it presents, relate to the form, situation, and size of its different component parts, and also to its vessels. Besides, its cavity not unfrequently includes foreign bodies, which depend particularly on alterations in the chemical composition of the urine.

DEVIATIONS OF FORMATION.

A. KIDNEYS.

§ 2379. The primitive deviations of formation in the kidneys,† which depend more or less evidently on a suspension of development,‡ are:—

1st. The *absence* of one or both of them.

2nd. *Smallness*, in which case when this anomaly occurs on one side only it is frequently, but not always made up by the greater size of the kidney of the other side.

3rd. The greater or less difference in the size of the two kidneys.

4th. The great size of these two organs.

5th. Their union in one only. This anomaly differs much in degree and quality.

The differences in respect to quality principally affect their ituation. Sometimes there is no trace indicating that a kidney has ver existed in the place where it is not found; the single kidney ocupies the usual place, follows the normal direction, and we discover hat it is formed by the union of the two, not only because it is arger than in the normal state, but also because it is contracted at s centre, from the excess in the number of its vessels, its fissure, elvis, and ureter. Sometimes the two halves of the single kidney re situated each in the usual place.

As to the difference in degree, the two kidneys are generally united nly at their lower part and to a greater or less extent, so that they

* Baillie, *Engravings*, London, 1812, fasc. vi-viii,—C. Bell, *Engravings from ecimens of morbid parts, preserved in the author's collection selected from the ivision inscribed urethra, vesica, renes, morbosa et læsa*, &c. London, 1813.—J. owship, *Practical observations on the diseases of the urinary organs, particurly those of the bladder, prostate gland, and urethra*, London, 1816.

† O. Heer, *De renum morbis*, Halle, 1790.

‡ See in respect to these deviations of formation, our *Handbuch der pathologischen Anatomie*, vol. i., p. 610.

form a semicircular mass, which is concave upward and convex downward. The union extends more rarely to their whole height, in which case they are changed into a rounded or square mass.

6th. They are more oblong than usual.

7th. The situation of the pelvis on the anterior face. These two anomalies generally attend enlargement, but they sometimes occur also although there is no mark of hypertrophy.

8th. The lobular structure, which sometimes gives rise to several separate kidneys.

Their low situation, so that sometimes we find the two kidneys in the pelvis.

§ 2380. Several of these anomalies are developed also during life only, as is true of abnormal enlargement and diminution. Not unfrequently, in fact, the kidneys enlarge sometimes to an enormous extent, although they change their texture, or on the contrary they disappear and are almost entirely effaced.

In the latter case sometimes they diminish much in volume, but their mass continues solid, or they even preserve their size or enlarge, but their substance is almost wholly destroyed, and they are changed into a sac with thin parietes. Wasting of the first kind supervenes after a disease of the organ; but not so with the second, which often depends on an obstacle to the escape of the urine which exists below the kidneys.

B. URETERS.

§ 2381. The deviations in the form of the ureter are particularly worthy of notice.

Their congenital anomalies are:—

1st. Their *absence.*

2nd. Their *imperforation* in one or several points, from an obstacle.

3rd. Their *plurality*, occurring from the want of union of the branches of the pelvis; this exists in different degrees.*

The most common consecutive deviation of formation is their abnormal dilatation or distension from an obstacle to the course of the urine situated in the ureter, or in another portion of the urinary system, or even out of it. Obstacles of the first kind are calculi and contractions; those of the second are the engorgement of the glands of the pelvis, the swelling of the internal genital organs, the adhesions of these parts either with each other or with the adjacent organs, &c.

Finally, the ureter is sometimes ruptured from excessive distension.

* Meckel, *Handbuch der pathologischen Anatomie*, vol. i., p. 715

C. BLADDER.

§ 2382. The primitive deviations in the form of the bladder are :—

1st. Its *absence*, attended or not with that of the rest of the urinary system.

2nd. Its *smallness*.

3rd. Its *fissure*. This anomaly is not very rare, and is termed the *prolapsus of the bladder** (*prolapsus vesicæ urinariæ inversæ*). Its principal characters are :

At the lower extremity of the anterior face of the abdomen, above the symphysis pubis, is a reddish, soft, rounded place, the edges of which are continuous with the common integuments, and at the base of which are two mammillary eminences directed one towards the other, whence urine continually dribbles. It is the bladder in the form not of a pouch but a layer, the anterior face of which is formed by its mucous membrane.

Behind this membrane is the muscular tunic, covered at its upper part by the peritoneum. The eminences are the orifices of the ureters situated in the usual place, and which are not generally abnormal, except from their great breadth.

The umbilicus is situated directly above the upper extremity of the bladder, and consequently much lower than usual.

The urethra then most generally opens above the penis in the male, and the clitoris in the female : it is more or less cleft, and more or less imperfectly developed Considered generally, the external genital organs seem to have separated from each other to the right and left.

Excepting at most two cases as yet published, the symphysis pubis is always more or less imperfectly closed, on which depends the apparent shortness of the penis.

Duncan† asserts that this anomaly belongs particularly to males : but the number of cases of its occurrence in females, mentioned by this author, may be much enlarged.

4th. The *bifurcation* of the bladder, or its formation by several connected sacs.‡

5th. The continuance of the urachus to the umbilicus, through which the urine then escapes.

§ 2383. The following anomalies are, at least commonly, consecutive or accidental.

1st. Excessive size. Here there is sometimes simple dilatation, and sometimes an increase in mass and volume. This anomaly generally depends on an obstacle to the course of the urine, situated at the lower part of the bladder or in the urethra.

* Meckel, *loc. cit.*
† *Edinb. med. and surg. journal*, 1805.
‡ J. A. Ehrlich, *Chirurgische Beobachtungen*, vol. ii., Leipsic, 1815, p. 123.

2nd. The considerable development of the muscular tunic, which sometimes occurs without dilatation, or even when the bladder is unusually small, which depends particularly on the presence of a foreign body, as a calculus, in the bladder.

3rd. *Hernias* of the inner membrane of the bladder through the muscular tunic (*appendices*, s. *processus*),* which are very rarely congenital, and commonly arise from the same cause as the preceding.

4th. *Ruptures* of the bladder, which are generally caused by its excessive distension.

5th. *Displacements*, *hernias* of the bladder. The bladder most generally projects at the base, and gives rise to *vaginal hernia* when it rests on the vagina, either because it has become very heavy, as in the cases where it is filled by a calculus, or because it is depressed by the contraction of the space it occupies, as in pregnancy. It then causes a more or less perfect inversion of the vagina, after which it is itself precipitated more or less, especially when the inversion is congenital.

We also find the bladder in inguinal hernias, but much more rarely.†

6th. When the bladder and vagina fall rapidly, there is sometimes an inversion of the bladder. The urethra is necessarily more or less torn, in order that this accident should supervene.

II. ALTERATIONS OF TEXTURE.

A. KIDNEYS.

§ 2384. The two kidneys do not always possess the same consistence. They are sometimes very flabby in persons affected with diabetes, in which case they frequently receive more blood than usual.

On the other hand they are sometimes unusually firm.

They are not unfrequently changed into fat.

Frequently also a great number of serous cysts are developed in these glands in old persons; these generally adhere, are filled with a differently coloured and generally a limpid serum, which sometimes entirely destroys their substance. In some cases the kidney seems formed primitively of similar cysts.‡

Scrofulous § and spungy tumours occur more rarely in the kidneys.

* Brocke, *De vesica urinariæ appendicibus*, Strasburg, 1754.—C. Bell, *Surgical observations*, pt. iv., London, 1817.

† Meckel, *Handbuch der pathologischen Anatomie*, vol. ii., p. 424.

‡ O. Heer, *De renum morbis*, Halle, 1790, tab. i.

§ Baillie, *Engravings*, fasc. iv., tab. viii.

B. BLADDER.

§ 2385. When the bladder enlarges, its membranes are also generally thickened by inflammation, become firmer, adhere more to each other, or are destroyed in parts.

The muciparous glands of the inner membrane are often enlarged in catarrh of the bladder.

Irregular, rounded, reddish tumours of various sizes are developed on this membrane, principally at the lower part of the posterior wall of the bladder; these rest upon a narrower base, and have no determinate texture. These tumours, called *funguses of the bladder* (*fongus vesicæ urinariæ*), are observed principally in males, and at an advanced age.

III. FOREIGN BODIES.

§ 2386. Of the foreign bodies most frequent in the urinary system, and consequently in the ureters and bladder, entozoaries are rare, and calculous concretions are very frequent.

A. ENTOZOARIES.

§ 2387. The entozoaries in the urinary system are:

1st. Hydatids,* which occur particularly in the kidneys, and perhaps are always primitively developed there.

2nd. The *strongylus gigas*, which exists in the kidneys.

3rd. Two other worms, as yet undetermined, which were voided with the urine.†

B. CALCULI.

§ 2388. The *urinary calculi* ‡ present several general and special important characters.

* Baillie, *loc. cit.*, tab. vii.-viii.

† Lawrence, *Case of a woman who voided a large number of worms by the urethra*; in the *Med. chir. trans.*, vol. ii.

‡ Tenon, *Sur la nature des calculs*; in the *Mém. de Paris*, 1765.—Scheele, *Untersuchung des Blasensteins*; in the *Schwedische Abhandlungen*, vol. xxxvii.—E. Sandifort, *De calculo renal.*; in the *Obs. anat. pathol.*, 1777, vol. i. p 6; *De calculis renum et vesicæ*, ibid., vol. iv., p. 7; *De lethali urinæ suppressione ex calculo urethræ inserto, indeque natâ duplici hujus canalis rupturâ*; ibid., vol. iii., p. 3.—F. A. Walter, *Anatomisches Museum*, th. i., Berlin, 1796.—Wollaston, *On gouty and urinary concretions*; in the *Phil. trans.*, 1797.—Pearson, ibid., 1798.—Fourcroy, in the *Annales du Museum*, vol. i.—Brande, in the *Phil. trans.*, 1808.—Magendie, *Recherches sur la gravelle*, Paris, 1818.—Prout, *An inquiry into the nature and treatment of diabetes, calculus, and other affections of the urinary organs, with notes and additions, by* S. Colhoun, M. D., Philadelphia, 1826.—Marcet, *Essai sur les affections calculeuses*, Paris, 1823.—F. A. G. Hoffmeister, *De calculis urinariis collectanea quædam*, Leipsic, 1821.

T T 2

§ 2389. Their general characters relate to their situation, texture, form, volume, number, mode of development, and effect on the organs which contain them.

1st. *Situation.* It varies both in itself, and in its relations with the urinary system.

a. Calculi occur in the cavity or in the parietes of this system.

The calculous concretions in the first are much more common than in the second.

Of the four parts in which they can be developed, the pelvis, the ureter, the bladder, and the urethra, they occur most frequently in the bladder, and most rarely in the urethra.*

The portion of the cavity of the urinary system which contains them, particularly of the bladder, is not generally separated from the rest by an abnormal septum. Sometimes, however, the calculi are inclosed in a special sac, which communicates with the common cavity by a narrow opening; they are then termed *encysted calculi.*

This state is doubtless in most cases the source of the calculi existing in the parietes of the bladder. We must admit that the communication at first existing is finally obliterated; it is impossible to suppose that the concretions were formed except within the cavity of the bladder.

b. Most generally, and even most always, the urinary calculi are entirely loose; but sometimes they are attached to the inner face of the bladder by mucus or thickened and coagulated fibrine, which exists between their prominences.†

2nd. *Texture.* The urinary calculi are generally formed of superimposed layers, more or less distinct and more or less concentric. Their centre also is usually formed by a nucleus, which most generally consists of a small mass of uric acid, more rarely of a foreign body accidentally introduced into the urinary apparatus, particularly the bladder.

The different layers are generally, but not always, similar in their chemical composition. They are always formed of at least two substances, one solid, the other softer and originally fluid, which unites and connects the particles of the preceding.

3rd. *Form.* The urinary calculi are more or less oblong and rounded, and generally smooth and a little flattened. This character depends in great part on the influence of the organ which contains them, the bladder being round. The form of the renal calculi demonstrates particularly the great influence of the form of the organ on that of these concretions.

* Ehrlich has described a very remarkable renal calculus. (*Loc. cit.*, vol. ii., p. 24.)

† Meckel, *Handbuch der pathologischen Anatomie*, vol. ii., pt. ii., p. 444.—Howship, *loc. cit.*, p. 249, tab. iii., fig. 5.—Bell, *Surgical observations*, London, 1818, pt. iv., p. 444, tab. i.

4th. *Volume.* The size of the calculi varies from that of an almost invisible grain to a diameter of several inches; they are sometimes so large that they completely fill the bladder, and even distend it.

5th. *Number.* Usually there is only one, or there are but few. When many exist their chemical composition is generally, but not always, the same.

6th. *Mode of development.* We may mention, as a general rule, that the formation of the calculi depends either on the abnormal state of the urinary system, or on the presence of a foreign body accidentally introduced into the bladder.

The abnormal state of the urinary system may vary in several different modes. The secretory portion is generally affected, so that an alteration in the chemical composition of the urine is most generally the cause of the formation of calculi. This accidental production depends more rarely on an abnormal arrangement in the bladder, or the excretory portion of the urinary system. It may, however, be caused by a mechanical obstacle to the emission of the urine, especially by sacs in the parietes of the bladder, by the hernia of the bladder, or by strictures of the urethra. Calculi have even been developed between the glans and the prepuce.*

7th. *Influence on the urinary system.* This influence varies. Whenever they are developed, the urinary calculi, being foreign bodies, cause more or less acute pains, the intensity and nature of which depend on their form, situation, number, and size, independent of the degree of sensibility of the patient.

The changes caused by them in the form of the urinary system are, the distension of the membranous parts, particularly the ureters, the thickening of the muscular portion, consequently of the bladder, which often attends their enlargement, but still more frequently the contraction of its cavity, finally rupture, which is more rare, and which occurs particularly in the urethra.

§ 2390. The peculiar characters of the urinary calculi relate principally and almost exclusively to their chemical composition.

Chemical analysis has discovered in them at this date uric acid, the phosphate of lime, the ammoniaco-magnesian phosphate, the oxalate of lime, and the cystic oxyd. There have been found also, but more rarely, less constantly, and in less quantity, silex, carbonate of lime, iron, and two other peculiar substances, the xanthic oxyd, and a fibrinous substance. Wollaston and Brande doubt the presence of urate of ammonia, admitted by Fourcroy and Vauquelin, and consider this salt as produced by the chemical analysis; but we cannot conclude positively from the arguments with which their opinion is supported that it never occurs in common calculi.

* Walter, *Obs. anat.*, Berlin, 1775, p. 74.—Penada, in Brera.—Meckel. *Handbuch der pathologischen Anatomie*, vol. ii., pt. ii. p. 444.

Sometimes these substances are distinct, and sometimes they combine in a greater or less number to form a concretion, whence numerous kinds of calculi are formed.

The simple calculi are :

1st. Those of uric acid, which are smooth, of a brownish red, and generally composed of concentric layers. They are the most common.

2nd. Those of phosphate of lime, which are proportionally rare, are white, and composed of layers easily separated.

3rd. Those of oxalate of lime are round, generally rough and brown; sometimes they are smooth, and seem to form always in the kidneys.

4th. Those of the cystic oxyd, more properly the renal oxyd, because this substance is very probably developed in the kidneys. These calculi are yellowish and semitransparent. They have no lamellar texture.

5th. Those of xanthic oxyd, which have been seen only once.

6th. Those of fibrinous matter, which also have been seen only once.

The calculi composed of different substances which do not form as many separate layers are:

1st. Those of the ammoniaco-magnesian phosphate, or the *fusible calculi* (*calculas fusibilis*) of Wollaston and Marcet, the most common next to those of the uric acid. They are white, and more friable than those of the other species. The ammoniaco-magnesian phosphate often predominates, although it seldom or never forms it alone. The calculi formed around the foreign bodies introduced into the bladder, those developed in ischuria, or between the prepuce and the glans, are most generally of this nature, because in this case the urine is more or less decomposed.

2nd. The more complex calculi are distinguished by their indeterminate form, their colour, their structure, which is not evidently in strata, and their hardness.

Finally, among the compound calculi, there are some in which the different layers are formed by as many distinct substances. The number of these substances varies from two to four : but there are generally but two, the uric acid, with a phosphate or oxalate of lime, with sometimes another phosphate, or with silex. In a calculus formed by four layers, Marcet has found, from the centre to the circumference, cystic oxyd, phosphate of lime, oxalate of lime, and the ammoniaco-magnesian-phosphate.

ARTICLE THIRD.

RENAL CAPSULES.

I. NORMAL STATE.

A. SITUATION.

§ 2391. The *renal capsules* (*renes succenturiati*, *capsulæ*, s. *glan-
læ suprarenales*, s. *atrabiliares*),* are triangular bodies, very flat
›m before backward, resting directly on the kidneys, to which they
united by a short cellular tissue. They occupy their upper ex-
mity and the upper part of their internal edge. Like them, they
situated on the outside of the peritoneum.

B. FORM AND VOLUME.

§ 2392. We have mentioned the general form of the renal capsules.
ey are more long than broad, that is, they extend farther from above
vnward than from right to left. They are only about one line thick.
eir form differs on the two sides: that of the left side is a little
;her and narrower than that of the right: the left is from fifteen to
enteen lines long, and about three broad: the right is generally
m fourteen to fifteen lines loug, and twelve or fourteen broad.
We remark on their external face the fissures through which the
od-vessels enter and depart. The left capsule usually presents
ward a longitudinal fissure, while there are two on the right side,
anterior and a posterior.

C. WEIGHT.

2393. Each renal capsule in the adult weighs about one drachm.

D. CONSISTENCE AND COLOUR.

§ 2394. These organs are quite firm but brittle. Their colour is
lowish brown externally, and a deep reddish brown internally.

A. M. Valsalva, *Diss. Anat.*, *III.*—B. Morgagni, *Epist. anat. XX.*—Duver-
', *Comm. Petrop.*, vol. ii.—Bœckler, *De thyroidæ, thymi et glandularum supra-
alium functionibus*, Strasburg, 1753.—J. C. Mayer, *De glandulis suprarenali-*
, Frankfort, 1784.—Riegels, *De usu glandularum superrenalium necnon de
gine adipis*, Copenhagen, 1790.—F. F. Leonhardi, *Diss. de glandulis suprare-
ibus*, Dresden, 1810.—J. F. Meckel, *Abhandlungen*, p. 1-277.

E. TEXTURE.

§ 2395. They are composed of two substances, one external, more consistent and yellowish, the other internal, softer and of a deeper brownish red. The first is evidently formed of perpendicular fibres, which are directed from without inward. These two substances are often intermixed, whence the capsule appears spotted externally. The external is divided more or less easily into rounded lobes, which may themselves be divided into lobules, and it is covered by a very thin serous membrane, which intimately adheres to its surface.

According to several anatomists, the renal capsules contain a more or less complex cavity. However, after much research, we are obliged to adopt the opposite opinion;* we think that there is normally no cavity, that it does not form till after death, and that it results either from the spontaneous decomposition of the inner substance, which is not very consistent, or from this substance being destroyed by handling it.

The substance of the renal capsules, particularly the internal, is very intimately and directly connected with the veins, for the liquids and air injected into these vessels easily penetrate them, and the air often forms in them a cavity, they are so soft.

§ 2396. The renal capsules are imperfect glands, as they have no excretory ducts. In fact, these ducts have been admitted by some anatomists of note, as Bartholini,† Peyer,‡ Valsalva,§ Ranby,‖ Kulmus,¶ Heuermann,** and Bendt.††. The capsules communicate with the testicles, according to Bartholini, Peyer, Valsalva, and Ranby; with the thoracic canal according to Kulmus, with the pelves of the kidneys according to Heuermann and Bendt. But very careful and numerous dissections have led us to the contrary opinion. The absence of an excretory duct in these organs seems more probable, as it accords with the researches of Morgagni.

II. DIFFERENCES PECULIAR TO THE RACES.

§ 2397. Some writers have asserted that the renal capsules were larger in negroes than in the Caucasian race, and that their medullary substance was darker.‡‡ We have seen nothing of this in dissecting a negro, although we had previously observed it in a negress.§§

* See our *Abhandlungen*, p. 17.
† Rhodii, *Mantissa*, p. 36.
‡ *Obs. anat.*; obs. 32.
§ *Diss. anat.*, *III.* Morgagni, *Ep. an. XX.*
‖ *Phil. trans.*, p. 385.
¶ *Bresl. Samml.* 1722, Feb.
** *Physiologie*, vol. iv. p. 97.
†† *De fabric. visc. uropæt.*, p. 17.
‡‡ Cassan, *Observ. med.* in Hufeland, *Annalen der franzœsischen Arzneywissenschaft*, vol. i. p. 475.
§§ *Handbuch der pathologischen Anatomie*, vol. i. p. 648.

III. DIFFERENCES DEPENDENT ON DEVELOPMENT.

§ 2398. The renal capsules are very easily distinguished in the
œtus of two months.

Their proportional size gradually diminishes on their first appear-
nce, and the same is true, at least frequently, of their absolute size
fter birth. They become thinner and dryer, wrinkle, and even en-
rely disappear in old age.* At the end of the third month they
re a little larger and heavier than the kidneys; at four months they
re equal in size to these glands, but they are lighter, because their
ssue is looser. At the commencement of the sixth month they are
nly half as large as the kidneys, but their weight is to that of these
tter as 2 : 5, since each capsule weighs ten grains, and each kidney
venty-five. In the full-grown fœtus the proportion is about as 1 : 3,
ach capsule usually weighs a little more than four scruples, and each
dney more than half an ounce. In the adult, on the contrary, the
lation is as 1 : 23, for the capsule weighs one drachm, and the kid-
ey three and a half ounces.

These organs are composed of lobes, which are at first more nume-
us and more distinct than in the adult; but they do not always
ntain a cavity in the early periods of life.

IV. FUNCTION.

§ 2399. It is very difficult to mention the function of the renal cap-
les, although their great size before birth indicates their importance.
We have every reason to think, that like the liver, the spleen, the
yroid, and the thymus glands, they contribute directly to the perfect
mation of the blood. Their great size in the fœtus, their free com-
unication with the venous system, and their nearness to the ascend-
g vena-cava, are at least so many circumstances in favour of this
njecture.

Those observers who admit an excretory duct to the genital organs,
cessarily connect the renal capsules directly with them. Other
ts, particularly their simultaneous, considerable development in
eral orders of the mammalia, had suggested the same idea to us,†
fore we knew that it belonged to another, but we could not des-
be the mode in which the renal capsules and the genital organs
operated.

We may also mention in support of this hypothesis, the coincidence
anomalies in the renal capsules with those in the genital organs.
us, Vauquelin has found the capsules ossified in a cat, from which
ovaries had been extirpated.‡ Lobstein has found that of the
t side tripled in size by a chalky mass in a man who had long been

* Bichat, *Anat. descript.*
† *Abhandlungen*, 1806, p. 161.
‡ Fourcroy, *Médecine éclairée*, vol. p. 236.

affected with syphilis.* We have found these organs unusually large in two individuals much addicted to venery,† and deformed in a female shortly after parturition, in whom the uterus and one of the ovaries also presented a similar formation.‡ Otto has seen them twice the usual size, in one case where the genital organs were very much developed.§

The great simultaneous development of these two orders of organs in the fœtus, the coincidence of their smallness, and even the simultaneousness of their absence with the development of the encephalon, between which and the genital organs there is so striking a connection in an opposite sense, are circumstances in favour of this hypothesis. Another conjecture very similar to this, is to consider the renal capsules as an imperfect rudiment of the genital organs,|| although it seems to us too doubtful to think, that if they were connected with the kidneys more intimately, an excess of energy, a momentary excitement alone would be necessary for this connection, acting like a real copulation, should cause the renal capsules to produce a new being.

It seems to us less probable that the renal capsules have a mechanical or dynamical relation with the kidneys, because, that when these latter are displaced, the capsules always preserve their normal situation, so that the two organs are then more or less distant.

Finally, it is still less probable that they contribute to produce the fat.¶

V. ABNORMAL STATE.

§ 2400. The renal capsules are very rarely abnormal,** and inasmuch as their anomalies consist in alterations of texture, we may conjecture with great probability, that they depend on the premature extinction of the great power primitively possessed by the organ.

A very general primitive anomaly, is their extreme smallness, or their entire deficiency, which attends the imperfect development of the encephalon, and the upper half of the body generally. Only two or three cases of this kind are known, where the renal capsules were found of their usual size. Their imperfect development not only attends alterations of the cerebrum, but the suspended development of this viscus generally, particularly congenital hydrocephalus.

* *Rapport sur les travaux anatomiques*, Strasburg, 1805.
† *Abhandlungen*, p. 185-186.
‡ *Ibid.*, p. 159.
§ *Pathologisch-anatomische Beobachtungen*, 1816, p. 139.
|| L. C. Treviranus, *Untersuchungen ueber wichtige Gegenstande der Naturwissenschaft und Medicin*, Gottingen, 1803, p. 184.
¶ Riegels, *loc. cit.*
** Lauth, in Lobstein, *loc. cit.*, p. 36.—Dupuytren, in Meckel, *Abhandlungen*, p. 141. Our observations perfectly agree with his.

The number of the renal capsules sometimes* increases, an interesting phenomenon, as it resembles one rather common in an adjacent organ, the spleen.

It is difficult to determine whether this state be only a simple division, or whether we should consider it as a real increase in the substance of the renal capsules. Considered in the last point of view, it would gradually lead to the hypertrophy of these organs, some cases of which are known.†

This hypertrophy is rare: we may presume that it generally depends on an alteration of texture, and it seems particularly coincident with anomalies in the genital organs.

CHAPTER IV.

OF THE GENITAL SYSTEM.

§ 2401. The *organs* of *generation*, the *genital parts* (*partes*, s. *organa sexualia*, *genitalia*, s. *generationi inserventia*),‡ principally serve to perpetuate the species, while the existence of the other systems is directly connected only with that of the individual. They however are directly connected with the organism of the individual, as is demonstrated by the consequences of their absence, whether primitive or congenital, or consecutive and accidental, or produced by a determination of the will. The sexual character which is imprinted on the whole organism, is most evident in them. Of all the organs then, these differ the most in the two sexes. A superficial examination would lead to the conclusion, that the genital organs in the male are entirely different from those of the female, and that they cannot be compared. But if we compare them in any animal, or even in man, we shall be satisfied that they have originally the same form, that they correspond perfectly in respect to number, their essential peculiarities in structure and function, that they differ only in size and situation, and that consequently, the analogies between them are much greater than the differences, and that they should be regarded as modifications of one and the same primitive type.

It is convenient to add the history of the mammæ to that of the genital system, since they contribute but slightly, or not at all, to the organism of the individual, while in their quality of nutritious organs of the infant, they exert a great influence on the preservation of the species. Besides, they do not differ less in the two sexes than the

* Duvernoy, *loc. cit.*—Morgagni, *Ep. XX. a.* 43.—Otto, *Seltne Beobachtungen*, I. lxxxiv.

† Harder *Apiar.*, obs. 61.

‡ F. Plazzoni, *De partibus generationi inservientibus, libri III*, Padoue, 1521.—W. Rolfink, *Ordo et methodus generationi dicatarum partium per anatomen cognoscendi fabricam*, Jena, 1661.—Id., *De sexus utriusque partibus genitalibus specimen*, Leipsic, 1675.—Van Horne, *Prodromus observationum suarum circa partes genitales in utroque sexu*, Leyden, 1668.

other organs of generation. It would be better then, instead of employing the expressions *sexual parts* and *genital parts* indiscriminately, as is generally done, to confine the latter term to the organs which produce the new being, that is, to the proper genital organs.

All these parts differ from most others, as their active state is proportionally very slight, for it generally does not extend much beyond the half of existence, during which it appears only at long intervals, and requires also, in order to be brought into action, very general, and often very great changes, both in the mode of vitality, and in the structure of the organs.

ARTICLE FIRST.

GENITAL ORGANS IN THE NORMAL STATE.

I. PROPER GENITAL ORGANS.

§ 2402. The proper genital organs occupy the lower part of the trunk, and are situated within and on the surface of the pelvis.

Those of the male and female differ principally in this respect, that the first are situated more externally, and are arranged more longitudinally, while the second are placed more internally. Those parts which in the male are situated on the outside of the abnormal cavity, exist in the female within the cavity of the pelvis, and even those which occupy the cavity of the pelvis in the male, are pushed forward so much that they are found directly below the common integuments. Thus, while the external genital organs in the female, those seen without opening the body, are much fewer and smaller than the internal, the opposite is true of the male ; but we shall demonstate hereafter, that this difference also does not exist during the whole of life.

§ 2403. The best mode is to divide the genital organs, in the two sexes, according to the functions of their different constituent parts; into the *proper genital* or *formative* organs (*organa generationis, s. formantia*), and the *organs of copulation* (*organa copulationis*).

The formative organs in the male, are the testicles with their excretory ducts, the prostate gland, and the glands of Cowper: in the female the ovaries with their excretory ducts, the Fallopian tubes, and the uterus.

The organs of copulation are, in the male, the penis; in the female, the vagina and the vulva.

§ 2404. In both sexes the genital organs are situated at the lowest extremity of the trunk, consequently, directly opposite to the encephalon. In both sexes they differ from the other organs in the symmetrical arrangement, their constituent parts existing in pairs, or in the contrary case, being situated on the median line of the body, which divides them into two equal parts.

A. GENITAL ORGANS OF THE FEMALE.

§ 2405. It is convenient to commence with the genital organs of ne female,* since the genital organs of the two sexes primarily ssume their form.

I. FORMATIVE ORGANS.

§ 2406. The *ovaries* and the *Fallopian tubes* deserve to be examined rst, on account of the period at which they appear, and their nportance.

A. OVARIES.

a. Form, situation, volume, and weight.

§ 2407. The *ovaries* (*ovaria*, s. *testes muliebres*) † are situated at ne upper part of the cavity of the pelvis, on the sides of the uterus, which they are attached only by the *ligament of the ovary* (*l. ovarii*), portion of the fold of the peritoneum, which attaches the uterus to ne pelvis, and is termed the *round* ligament. They are rounded and blong. Their anterior and posterior faces are convex. Their upper lge is also convex and loose. The lower is straight or a little con-ve, presenting a real *vascular fissure* (*hylus*). They rest by this tter edge on the upper part of the broad ligament. They become inner towards their internal and external extremities, but particu-rly toward the former.

Their surface is usually smooth in virgins, and generally uneven d lacerated in aged females. When perfectly developed, they are out an inch and a half long, about four or five lines high, and a tle less in thicknes. They weigh about a drachm and a half.

b. Structure.

§ 2408. The ovaries are covered externally by the peritoneum, low which is a very solid and very resisting white fibrous mem-ane (*tunica albuginea*). These two layers are inseparably united. ne internal is perforated at the lower edge of the gland by vessels hich pass through it, and are distributed in its tissue.

* R. de Graaf, *De mulierum organis generationi inservientibus*, Leyden, 1672. J. Palfyn, *Description anatomique des parties de la femme qui servent à la génération*, Leyden, 1708.—D. Santorini, *Obs. anat. cap.* XI. *De mulierum partibus ocreationi datis.*—J. G. Gunz, *Observationes de utero et naturalibus fœminarum*, ipsic, 1753.

† C. Bartholin, *De ovariis mulierum et generationis historia*, Rome, 1677.—sch, *De ovario mulierum*, Jena, 1618.—Motz, *De structura, usu, et morbis ariorum*, Jena, 1789.

When we cut the ovaries, their tissue appears brownish red, they are very vascular, firm, and solid, and vesicles are situated within them.

§ 2409. These *vesicles** are termed the *ovula of Graaf* (*vesiculæ*, s. *ovula Graafiana*), although they were known previously by Vesalius† and Fallopius.‡

In the normal state they are composed of a thin, smooth, and serous membrane, which adheres intimately to the substance of the gland; they are entirely closed and filled with a clear and limpid fluid. They vary in size, and they seem to be developed successively. The largest are about three lines in diameter, they are more numerous on the edge of the ovary than in the centre. In virgins their number varies from eight to twenty.

B. FALLOPIAN TUBES.

§ 2410. The *Fallopian tubes* (*tubæ Fallopianæ*, s. *meatus seminarii*)§ are the excretory ducts of the ovaries. They are situated before and below these organs, then go from without inward toward the upper edge of the uterus, passing through the upper end of the broad ligament (*ala vespertilionum*), to which they are attached.

They are very tortuous, especially in their external portion, and gradually enlarge, so that their diameter, which is only half a line on the inside, becomes by degrees three and four lines. They open into the abdomen (*ostium abdominale*) by a mouth surrounded with a fimbriated edge, called the *morsus diaboli*. This opening projects much on the outside of the outer extremity of the ovary. The internal orifice (*ostium uterinum*) opens in the angle formed by the union of the upper edge of the uterus with its sides. There is no mark of valve or prominence here. Each tube is about five inches long.

§ 2411. The tubes are covered by the peritoneum, which forms their external tunic, and which is continuous with the inner membrane on the edges of the abdominal orifice.

Below the peritoneal tunic is the middle membrane, in which we cannot usually observe any fibres, but it is sometimes composed in vigorous females of two muscular layers, which are formed, the external by longitudinal fibres, and the internal by circular fibres.‖

The internal mucous membrane is smooth, and presents numerous longitudinal folds.

* Bartholin, *De fœminarum ovis*, Leyden, 1684.
† *De corporis humani fabricâ*, lib. v. cap. xv. p. 459.
‡ *Obs. anat.*; in the *Opp. omn.* Venice, 1606, vol. i. p. 106.
§ Bartholin, *De tubis uteri*, Leyden, 1684.
‖ Santorini, *loc. cit.*

C. UTERUS.

§ 2412. The *uterus* or *matrix** is the largest of those parts which unite to form the genital system in the female.

a. Form.

§ 2413. It is pyriform, and much more extensive from above downward than from right to left. Its thickness is much less than its breadth. Its upper and largest part, which is termed the *body*, is triangular. It gradually contracts toward the base. The lateral edges are straight, the upper is very convex.

The upper part of the body is called the *base* (*fundus uteri*). The inferior, termed the *neck* (*collum*, s. *cervix uteri*) is nearly cylindrical.

The anterior and posterior faces of the uterus are very convex, the second more so than the first, so that particularly in the early periods of life, we may admit two posterior lateral faces, which unite at an obtuse angle on the median line.

The uterus represents a cavity closed at its upper part, always excepting the narrow orifices of the two Fallopian tubes, but open below and continuous in this direction with the vagina.

§ 2414. The parietes of this organ are very thick, firm and solid, in the perfect state. The middle region of its body, its thickest por-

* J. A. Pratis, *Libri duo de uteris*, Antwerp, 1524.—L. Bonaccioli, *De uteri sectione*, Strasburg, 1529.—M. A. Ulmus, *Uterus muliebris*, Bologna, 1601.—J. Swammerdam, *Miraculum naturæ de uteri muliebris fabricâ*, Leyden, 1672.—C. Drelincourt, *De utero*, Leyden, 1682.—M. B. Valentini, *De novâ matricis anatome*, Giessen, 1683.—G. Bartholin, *De utero*, Leyden, 1684.—A. Nuck, *Adenographia curiosa et uteri feminei anatome nova*, Leyden, 1692.—F. Ruysch, *Tractatus de musculo in fundo uteri observato, antea a nemine detecto*, Amsterdam, 1726.—A. Vater, *De musculo novo uteri*, Amsterdam, 1727.—J. J. Huber, *Uteri muliebris partiumque ad eam facientium præcipuarum iterata explicatio*; *Halleri Icones*, fasc. I.—I. U. Buchwald, *De musculo Ruyschii in fundo uteri*, Copenhagen, 1741.—J. Weitbrecht, *De utero muliebri observationes*; in N. C. Petrop, vol. i, p. 337.—Sue, *Recherches sur la matrice*; in the *Mém. pres.*, vol. v.—J. G. Rœderer, *Icones uteri humani observationibus illustratæ*, Gottingen, 1759,—T. Simson, *Observations concerning the placenta, the two cavities of the uterus, and Ruysch's muscle in fundo uteri*; in the *Edinb. med. essays*, vol. iv. n. 13.—J. G. Walter, *Betrachtungen über die Geburtstheile des weiblichen Geschlechtes*, Berlin, 1776.—J. C. Loder, *De musculosâ uteri structurâ*, Jena, 1782.—J. G. Weisse, *De structura uteri non musculosa sed celluloso-vasculosa*, Wirtemberg. 1784.—G. Azzoguidi, *Observationes ad uteri constructionem pertinentes*, Leyden, 1788.—O. F. Rosenbergen, *De viribus partum efficientibus generatim et de utero speciatim, ratione substantiæ musculosæ et vasorum arteriosorum*, Halle, 1791.—C. H. Ribke, *Ueber die Structur der Gebarmutter*, Berlin, 1793.—G. C. Titius, *De uteri structura ex. ejusdem functionibus*, Wirtemberg, 1795.—J. F. Lobstein, *Fragment d'anatomie physiologique sur l'organisation de la matrice*, Paris, 1803.—J. C. G. Joerg, *Ueber das Gebarorgan des Menschen und der Säugthiere im schwangern und nicht schwangern Zustande*, Leipsic, 1808.—C. Bell, *On the muscularity of the uterus*; in the *Med. chir. trans.*, vol. iv. 1813, p. 335.—J. B. Belloni, *Memoria sopra la vera struttura dell'utero*, Rovigo, 1821.—Mad. Boivin, *Mémorial de l'art des accouchemens*, Paris, 1824, p. 57.

tion, is half an inch thick. The body is a little thicker, but perhaps a litter softer than the neck.

The anterior and posterior parietes gradually grow thin on the outside, and the internal upward, so that their thickness diminishes from four or five lines to one, and thus resembles that of the tubes, which proceed some lines in the substance of the organ, following an oblique direction from above downward, and from without inward.

The form of the cavity of the uterus generally corresponds with its external figure, although it is extremely narrow in regard to the thickness of the parietes, whence it follows, that its anterior and posterior faces almost touch. Its mean breadth does not exceed four lines. The three edges of the body are concave outward and convex inward, while externally, only the upper edge of the uterus is convex outward. The cavity of the neck is circumscribed by faces convex outward, while its outer face is concave, as the organ is contracted a little on its centre. The form of the cavity also differs from that of the outer circumference, in this respect, that it extends above on each side into a long horn, which gradually contracts, and at the summit of which the Fallopian tube opens.

The cavity is narrowest in the neck, particularly on the limit between the neck and the body, where it contracts very much. It is termed in this place the *upper* or *internal orifice of the uterus* (*ostium uteri internum*).

Thence, the neck enlarges to about its centre, and then again contracts. It terminates below in the upper extremity of the vagina, by two sacs, an anterior and a posterior, the latter of which is usually longer, but the anterior descends a little lower, and between which we usually observe a transverse fissure, more rarely a smaller rounded opening, termed the *os tincæ*, the *external* or *vaginal orifice of the uterus* (*orificium uteri externum, os uterinum*). The two sacs are termed the *lips* (*labia*) of this orifice.

The inner face of the uterus is smooth in the body, but corrugated in the neck, along the anterior and posterior parietes of which is a longitudinal prominence, which gradually diminishes from above downward, the sides of which present oblique bands, which render it very uneven. On the sides between the two prominences we observe also numerous elevations, which intercross like a net-work. The lips of the os tincæ are smooth, at least if we expect lacerations, which are always accidental, and occur rather frequently during parturition.

b. Volume.

§ 2415. In virgins the uterus is about two inches long, nearly half of which is formed by the neck. The greatest breadth of the body is sixteen lines, and that of the neck from nine to ten. The lips of the os tincæ are about ten lines broad, and the breadth of the external orifice of the uterus is about six.

The vaginal portion of the uterus is about six lines thick, and the issure is very narrow in this direction.

In females who have borne children the uterus commonly never eturns to its primitive dimensions, and the orifice of the os tincæ ılso appears a little broader from before backward.

c. Weight.

§ 2416. The well developed uterus of a virgin weighs between even and eight drachms; but in a female who has borne children, nd in whom the uterus has contracted as much as possible, it often eighs an ounce and a half.

d. Situation.

§ 2417. The uterus is situated between the bladder and rectum. s upper half is placed in the cavity of the peritoneum, a fold of hich is intimately attached to its surface.

In the perfect state it is situated entirely in the small pelvis, and s base rises only to the level of the upper edge of the symphysis ıbis. This part is directed forward and upward: the os tincæ, on e contrary, downward and backward, so that the longitudinal diaeter of the axis of the organ corresponds nearly to the upper axis of e pelvis, and it cuts the axis of the body backward and downward.

e. Attachments.

§ 2418. The uterus is attached to the adjacent parts by several ids of peritoneum,* which are continuous with the serous tunic of body, from whence they arise inward.

The largest are the *lateral* or *broad* ligaments (*l. uteri lateralia*, s. *a*). They pass from the lateral edges of the uterus, receive the vess of this organ between their anterior and posterior layers, go ınsversely outward toward the circumference of the pelvis, divide is cavity into two halves, an anterior and a posterior, the first of ich is smaller than the second, and are continuous with the lateral .ll of the peritoneum.

Beside these vessels, this fold of the peritoneum possesses more or s distinct transverse muscular fibres, which leave the lateral edge the uterus and gradually terminate on the outside.†

J. C. Schutzer, *De fabricà et morbis ligamentum uteri*, Harderwyck, 1729.—Petit, *Description anatomique de deux ligamens de la matrice nouvellement erves*; in the *Mém. de Paris*, 1760.—A, Portal, *Observ. sur la structure des ties de la génération de la femme*; in the *Mém. de Paris*, 1770, p. 183.

Sue, *Recherches la Matrice*; in the *Mém. pres* , vol. v., p. 248.

Another fold which is much smaller, elongated, and rounded, forms on each side the *posterior inferior* ligament, or the *semilunar fold of Douglas* (*l. uteri inferius posterius*, s. *plica semilunaris Douglasii*), which extends from before backward from the lower part of the posterior face of the uterus to the rectum.

This ligament also contains longitudinal muscular fibres.*

A third, which is still smaller, the *inferior anterior* ligament (*l. uteri inferius anterius*), one of which generally exists on each side, extends from behind forward, from the lower part of the anterior face of the uterus to the bladder, embraces this latter, and frequently also possesses muscular fibres.

Finally we find on each side a very long and rounded ligament, which leaves the upper part of the lateral edge of the uterus, directly below and before the inner extremity of the Fallopian tube; it is termed the *round* ligament (*l. uteri rotundum*, s. *teres*). This ligament is first situated between the two layers of the broad ligament, passes behind the umbilical artery and before the hypogastric vessels, is directed from below upward and from within outward directly behind the peritoneum, towards the upper and external orifice of the inguinal canal, is reflected in this place on the epigastric artery, then enters the inguinal canal, proceeds from above downward, from without inward, and from behind forward, emerges from the inguinal canal through the inguinal ring, and terminates by dividing into several fasciculi in the fat of the mons veneris, and in the upper part of the external labia

It is composed principally of cellular tissue and vessels, but it possesses also some very distinct longitudinal muscular fibres, the upper of which arise from the external layer of the fibres of the uterus, while the lower come from the lower edge of the two internal broad muscles of the abdomen, which are directed from below upward.

These ligaments keep the uterus in place. The muscular fibres of the broad ligament serve also to approximate the Fallopian tubes to the ovaries.

When the fibres of the broad and round ligaments of one side act more forcibly than those of the opposite side, the uterus is carried transiently or permanently into one half of the pelvis, an arrangement which we have often observed, although it depended on no mechanical cause, and although the parts which serve to retain the uterus were unaltered in their texture.

f. Texture.

§ 2419. At first view the tissue of the uterus seems to be homogeneous; we however distinguish in it when unimpregnated, several layers superimposed from behind forward, which have a reddish yellow colour, and between which are whitish bands.

* Sue, *ibid.*

The vessels of the uterus, which are very tortuous and frequently anastomose together, proceed between these layers both on the anterior and near the posterior face.

a. Fibres.

§ 2420. There is perhaps in anatomy no subject on which opinions are more divided than in respect to the fibres of the uterus, or, to state the question more exactly, in regard to the existence of these fibres generally, their nature, and their arrangement.

1st. Several anatomists, particularly Walter, Bœhmer, Blumenbach, Azzoguidi, and Ribke, formally deny their existence, which is admitted, on the contrary, by Vesalius, Piccolomini, Malpighi, Morgagni, Diemerbroek, Verheyen, Vieussens, Ruysch, Vater, Santorini, Buchwald, Weitbrecht, Monro, Noortwyk, Heister, Haller, Sue, Astruc, Levret, Rœderer, Meckel, Hunter, Wrisberg, Loder, Mayer, Simson, Calza, Lobstein, and Bell.

Thus the second opinion, which we also have adopted, is supported by most authorities.

But the anatomists who admit their existence differ; some consider the fibrous texture of the uterus as constantly existing; while others, who are more numerous, think that these fibres exist only in certain conditions, as in gestation.

It is a fact that these fibres are at least very slightly apparent, except in pregnancy. They however do not form only during this state, but whenever the formative power of the uterus is exalted. Lobstein has found them very apparent in a female where the uterus was much distended by a steatomatous tumour, as it is generally in the seventh month of pregnancy. He attributes this phenomenon to the distension caused by the tumour; but we have observed them more or less evidently in the uterus of females where analogous tumours existed in the uterus and ovaries, so that we think it more correct to admit that they depend on a change of the proper vitality of the uterus.

2nd. Most anatomists consider these fibres as muscular. In fact they differ from the red fibres which form the voluntary muscles, as they are less red, flat, and strongly united with each other; but their muscular nature is proved by their powerful contraction, either during parturition to expel the fœtus and the secundines, or afterward, to contract the uterus and almost obliterate its cavity very rapidly.

In these two characters they are very analogous to the involuntary muscles.

This in fact is the manner in which the fibres of the uterus act, and their substance presents in the different states of this organ the different modifications observed in the muscular system of organic life, that is, when the uterus is unimpregnated, they resemble the fibres of the arteries, and during gestation, those of the other involuntary muscles, except the heart.

The uterus of the female contains also a great proportion of fibrine. Finally we may also mention the analogy with the mammalia, where the uterus is evidently muscular at all periods of life, adding however that by a very remarkable arrangement, the fibres in the uterus of the female do not evidently possess this character, except when the formative power of the organ is increased.

3rd. The direction of the fibres is not described in the same manner by all anatomists. Most of them, however, agree that they possess at least two directions, a longitudinal and a tranverse; so that in this respect also they resemble the muscles of organic life.

They are however more complex, since we find several layers proceeding in different directions, as the layers composed of fibres which have the same direction proceed several times from within outward; and as finally the different layers frequently interlace together.

Some authors, particularly Malpighi and Monro * maintain that the fibres are not arranged regularly.

Ruysch admits only a single, unmated, and circular muscle, situated at the base of the uterus. Although several anatomists, as Vater, Monro, and Simson agree with him, it is however certain that the arrangement of the fibres of the uterus is not so simple. Farther the description Ruysch has given of this muscle is not perfectly exact.

The following are the most general characters of the arrangement of the muscular fibres of the uterus:

1st. There are two layers, an external and an internal, which are separated by the vascular substance of the organ.

2nd. The different planes and layers are interlaced so intimately that it is difficult to separate them.

3rd. The external layer is much thicker than the internal.

4th. The muscular substance is much thicker at the upper part of the uterus, particularly in its base, than in the other regions. It does not exist at all, or at least is very thin, in the neck.†

5th. Generally speaking the longitudinal fibres are much more numerous than the others. The circular fibres, however, are more developed at the base of the organ, while the longitudinal fibres are larger near the lower orifice.

6th. The external plane is composed of longitudinal fibres, which depart from the centre of the base, are distributed from above downward on the anterior and posterior faces, follow an oblique and even transverse direction, and disappear toward the neck. Some of these fibres are irregular, others are continuous with the round ligaments.

7th. According to some authors, Rosenberger for instance, the external plane is composed only of longitudinal fibres; there are however below these fibres other transverse fibres which also go to the round ligaments and to the Fallopian tubes.

* *Dissection of a woman with child, with remarks on the gravid uterus*; in the *Edinb. phys. and Med. Essays*, vol. i., p. 459 and 470.

† Bell, *loc. cit.*, p. 342.

8th. We also remark in this plane, oblique fibres which have very lifferent directions, and are tortuous; these interrupt particularly he longitudinal layers, and occur principally at the lower part of the ody.

9th. The oblique fibres do not exist in the neck, which however is omposed, at least frequently, of several superimposed layers of trans- erse and longitudinal fibres.

10th. The inner plane, which is the thinnest, is formed of two ayers. The external is composed of two circular muscles, each situ- ted round one of the orifices of the tubes; they blend together on he median line anteriorly and posteriorly, by the inner part of their dge. Very probably one of these circular layers is the muscle of uysch, who had considered the lateral wall of the uterus as the up- er, and had neglected the opening of the tube.

11th. Below this layer are longitudinal and oblique fibres, which nite on each side anteriorly and posteriorly to form two elongated iangles, the summits of which blend in the orifice of the tube.

12th. Below these fibres, and interlacing with them, are rather ansverse and indistinct fibres, seen particularly at the lower part of he uterus.*

* Mad. Boivin describes the fibres of the uterus differently. She remarks that fter macerating the uterus for a few days, we observe on each face six fibrous fas- culi, three on the right and three on the left of each wall, besides one which is rtical, and which forms the median line. This last layer, which extends om the circumference of the base to the base of the body, presents longitudinal ores. Each of the others seems to arise from the median line: 1st, at the ntre of the base are two fasciculi, one on each side, which extend trans- rsely on the edge of the base to the upper angles, where they fold in the rm of tubes, which separate and extend to form the tubes; 2nd, below this first yer of the anterior face, two other broader layers, which occupy the upper alf of the body. proceed horizontally on each side from the median line, and little before the angle of the tube, to unite to other layers of fibres, and ere form the origin of the round ligament; 3rd, at the lower third of the me- an line two other layers of fibres are directed obliquely from below upward, parating on the sides; one portion of this fasciculus unites to the band of res of the round ligaments, and the other blends and interlaces with the ansverse fibres of the posterior regions of the organ. On the posterior wall the uterus the arrangement of the fibrous layers is nearly the same as in the iterior wall. The middle layer is more prominent than that of the anterior ce, and also presents longitudinal fibres. The fibrous layers of the upper gion extend across, leaving the median line, to the origin of the tubes and little below, where they unite to go to the ovaries, of which they form the gament Below is another layer, which reascends obliquely and divides rather stant from their point of departure into two portions; one superior and late- l, turns on the side, and goes to unite forward to the round ligaments; the her terminates in the form of a ring, and goes to the base of the ovary. At the wer extremity of the median line in the external central region of the neck e two other fasciculi, which are composed of a portion of the fibres of the edian line of the neck, separate some lines from each other, are insulated, and e attached to the lateral edges of the middle region of the sacrum, and form the osterior ligaments.

These different fibrous layers change their direction during pregnancy. In pro- ortion as the body of the uterus elongates and enlarges, the layers of fibres of the per regions from transverse become oblique, their median extremities rise to- ards the middle of the base, and their lateral extremities are depressed, in the same oportion, to the lower third of the lateral edges of the organs, so that at the end of station the fibrous layers of the upper and lateral regions have a radiate arrange-

b. Internal surface.

§ 2421. The inner surface of the uterus is covered by a reddish mucous membrane, which is almost smooth, and presents only some very small villosities, which are continuous above and on each side with those of the tubes, and below with that of the vagina.

In the recent state this membrane adheres so intimately to the subjacent fibrous substance that it is inseparable, although its structure intimates distinctly that it belongs to the class of mucous membranes; but after macerating the uterus we can detatch some folds of it by care and precaution.

Its intimate union with the rest of the substance of the uterus has caused its existence to be doubted by several anatomists,*

We find some muciparous glands only in the neck, particularly at its lower part. Not unfrequently their orifice is obliterated, perhaps from inflammation. They then form more or less numerous large cysts filled with a limpid liquid, produced by the accumulation of their habitual secretion.

These cysts are termed the *ovula of Naboth* (*ovula Nabothiana*, s. *ovarium secundarium*),† which have been very badly compared to the ovula of Graaf.

ment, and may be compared to a head with long hair, separated in all the extent of the median line of the skull, smooth on each side of the forehead, and situated very near and before each ear; this union in a single fasciculus of these superior fibrous layers forms forward and on each side the broad ligaments. The layers of fibres of the lower region of the body have lost progressively the oblique direction assumed by them at first, and become semicircular. The fibrous layers, which leave the lower portion of the median line, unite on the sides and before the middle region of the uterus to the broad ligaments, an inch below the union of the superior fasciculi. The direction of the fibrous layers of the posterior wall is changed in nearly the same manner as those of the anterior face. These layers, which are at first transverse, are arranged obliquely from above downward, and turn on each side. One portion is attached to the ovary, and then projects on the lateral face of the uterus, and the other passes below those glands to unite forward to the anterior fasciculi which form the round ligaments, whence it follows that not only the fibrous layers of the anterior region of the uterus, but also a portion of the middle layers of the posterior region, contribute to form these ligaments. The median layers, which are arranged longitudinally, extend from the base to the origin of the internal orifice of the neck, loose their vertical direction by separating progressively on the sides, and appear at the end of gestation a kind of tissue of fibres, which intercross, and from whence proceed the other layers of fibres, which have been described (*Mémorial de l'art des accouchemens*, Paris, 1824). F. T.

* This is the opinion of Chaussier and Ribes. Mad. Boivin says also she has never seen this mucous membrane, and thinks that the inner face of the uterus is formed only by the extremities of the exhalent vessels which open there. (*Memoria, des accouchemens*, p 66.) This explanation is very vague, if not unintelligible. Analogy does not admit us to doubt that the inner face of the uterus is covered by a membrane. F. T.

† M. Naboth, *De sterilitate mulierum*, Leipsic, 1707.

II. ORGANS OF COPULATION.

§ 2422. The organs of copulation are composed, in the female, of he vagina, the clitoris, the external labia, and the nymphæ; the hree latter have been termed the *external genital parts* (*pudendum*, s. *unnus*), in opposition to the others, termed the *internal*.

A. VAGINA.

a. Form and dimensions.

§ 2123. The *vagina* is a membranous canal, with thin parietes, ge- erally about four inches long and one broad, and larger at its up- er than at its lower part; it is directly continuous with the uterus.

Its upper extremity terminates in a cul-de-sac, called the *base fundus vaginæ*), and is continuous with the substance of the uterus, mbracing its lower or vaginal portion.

The other extremity is narrower, and is termed the *entrance* of the agina (*aditus vaginæ*): it opens externally where it is continuous vith the external labia.

b. Situation and direction.

§ 2124. This canal is situated between the rectum, the bladder, nd the urethra, to which parts it is united by very loose cellular ssue. It has not the same direction as the uterus, for it descends om behind forward, so that its axis corresponds exactly to the lower xis of the pelvis.

Farther, its posterior wall is slightly convex, and the anterior is ncave.

c. Texture.

§ 2425 The vagina is formed of two layers, one external, very in, solid, and reddish white, which corresponds to the muscular and iscular tunics, is continuous with the fibrous tissue of the uterus, id gradually becomes more solid and vascular from without inward; e internal is reddish, and is firmly united to the preceding, from hich however it may be separated.

It is very much corrugated in a full grown female, and particularly virgins.

Among these folds we see, particularly on the anterior and posterior ces, a series which is transverse and oblique, situated one above other (*columna rugarum anterior et posterior*), which are the conti-

nuation of those in the neck of the uterus, where they are termed the *arbor vitæ*.

There are some muciparous glands at the upper part of the vagina.

B. HYMEN.

§ 2426. The *hymen* (*hymen*, s. *valvula vaginæ*)* is a semicircular fold of the mucous membrane of the genital parts, formed of two layers united by cellular tissue; it occupies the sides and the posterior part of the entrance of the vagina, and leaves a greater or less space between its anterior concave edge and the anterior part of the vagina.

Not unfrequently this fold arises from all the edge of the canal. Even then however the opening is generally situated forward and rarely in the centre; the hymen is rarely also thick, hard, solid, and muscular.

This membrane separates the internal and the external genital organs, and also the genital and the urinary systems, as we perceive before it the orifice of the urethra, surrounded by small similar folds.

C. CLITORIS.

a. Clitoris in itself.

§ 2427. The *clitoris* (*clitoris*, s. *membrum muliebre*, s. *coles feminarum*, s. *nympha*)† is an oblong, rounded body, situated below the symphysis pubis. It arises from the upper part of the inner face of the ascending ramus of the ischium by two branches about an inch long, which unite at an obtuse angle.

It terminates forward by a small elongated and rounded prominence, called the *glans of the clitoris* (*G. clitoridis*). This enlargement is covered by a thin mucous membrane, and by a thick and soft epidermis, which is easily detached, and it is surrounded by a triangular fold of skin which entirely envelops it.

This fold of skin, termed the *prepuce of the clitoris* (*præputium clitoridis*), which is closed above and open or cleft below, is thin, soft, and moist on its two faces, but particularly on the internal. We remark in it, especially where the prepuce is continuous with the skin which surrounds the glans of the clitoris, a great number of sebaceous glands.

* A. Vater, *De hymene*, Wittemburg, 1727.—J. J. Huber, *De hymene et vaginæ rugis*, Leyden, 1742.—B. S. Albinus, *De hymene*; in the *Annot. acad.*, Leyden, 1758, l. iv., x.—Goering, *De hymene*, Altdorf, 1765.—G. Tolberg, *De varietate hymenum*, Halle, 1791.—B. F. Osiander, *Abhandlung über die Scheidenklappe*; in his *Denkwürdigkeiten für dei Geburtshülfe*, vol. ii., pt. i., p. 1.

† T. Tronchin, *De nymphâ*, Leyden, 1730.

On a more attentive examination, we remark that the glans is not a continuation of the substance of the posterior part of the clitoris, but is attached to it only by cellular tissue, vessels, and nerves, and that the posterior part of the clitoris terminates by a concave surface destined only to support it.

§ 2428. The clitoris is composed of an external fibrous sheath, below which is a spongy tissue formed by broad venous trunks, which frequently anastomose. Thus these lateral parts are termed the *cavernous bodies* (*C. cavernosa*, s. *spongiosa clitoridis*).

After the two branches by which it arises unite, we observe between its two lateral halves a perpendicular fibrous septum, which separates them imperfectly, and which is directly continuous with the external envelop.

There is no trace of a septum in the glands, which is formed of a similar but finer tissue.

By reason of this texture the clitoris is capable of enlarging very much.

Its vessels and nerves proceed on its dorsal face, which are very considerable; they are numerous and enter, particularly the latter, into the glans.

b. Ischio-cavernosus muscle.

§ 2429. The branches of the clitoris are covered at the lower part of their edge and on each side by a muscle, which arises directly below their lower extremity by short tendinous fibres; these are attached to the inner branch of the ascending ramus of the ischium, and extend almost to their other extremity. This muscle is called the *ischio-cavernosus* muscle (*M. ischio-cavernosus*, s. *director*, s. *depressor clitoridis*).

It depresses the clitoris, and may contribute to expel the blood which collects in it during erection.

D. NYMPHÆ.

§ 2430. The *small* or *internal labia*, or the *nymphæ* (*L. pudenda internæ*, s. *minores*, s. *nymphæ*), are two oblong, reddish, corrugated folds, similar to the crest of a cock, and very much compressed from right to left; they are connected posteriorly, and their anterior extremities unite in the glans of the clitoris. The skin which covers them is very delicate, soft, moist, destitute of hair, and similar, especially on its inner side, to a mucous membrane.

Their inner face is continuous with the vagina, and the external with the external labia.

They are formed by a spungy tissue, called the *cavernous body of the nymphæ* and *glans* (*corpus cavernosum nympharum et glandis*),

which is finer than that of the clitoris, but is similar to that of the glans, of which it is the direct continuation.

The two branches of the prepuce terminate near the anterior and upper extremity of these folds, and are continuous on the outside with them.

Hence it follows that the nymphæ divide at their anterior extremity into two branches; the internal, which is the smaller, enters into the glans, and the external, or the larger, terminates in the prepuce, and their spungy tissue unites with that of the glans.

The space between them is termed the *vestibule* (*vestibulum*).

E. EXTERNAL LABIA.

§ 2431. The *great* or *external labia* (*L. pudendi externa*, s. *magna*) are considerable folds of skin, directed from before backward, which envelop the other external genital parts. Their external fold is formed by the skin: the internal by a very thin mucous membrane, which is continuous with that of the nymphæ.

They unite anteriorly and posteriorly, thus forming the *anterior* and *posterior commissures*. They are imperceptibly continuous forward with the mons veneris. They are united posteriorly, on the inside and above the posterior commissure, by a thin and transverse fold, termed their *frenum* (*frenulum pudendi*).

The space between the frenum and the posterior commissure is termed the *navicular fossa* (*fossa navicularis*).

F. MUCOUS CRYPTS OF THE EXTERNAL GENITAL PARTS.

§ 2432. The external genital parts are provided with numerous large mucous crypts; they abound particularly around the orifice of the urethra and the entrance of the vagina. The first have been termed the *prostate of Bartholini* (*prostata Bartholiniana*).*

G. CONSTRICTOR VAGINÆ MUSCLE.

§ 2433. The upper extremity of the external genital organs in the female is surrounded on a level with the nymphæ by a thin, long, round, and muscular layer, which blends posteriorly with the anterior extremity of the sphincter ani externus muscle, and is attached forward to the branches and the body of the clitoris. This is the *constrictor vaginæ* muscle (*M. constrictor cunni*).

This muscle powerfully contributes to contract the entrance of the vagina.

* Bartholini, *De ovariis*, p. 21.

III. VESSELS AND NERVES.

§ 2131. The female genital organs receive their vessels from two ources, principally from the spermatic arteries and the branches of e hypogastric arteries; they are termed the uterine and vaginal rteries, and the arteries of the clitoris, and they are distributed in e parts of the same name. Some twigs of the internal pudic ar-ery also go into the external labia.

The synonymous veins carry the blood into the crural, the hypo-astric, and the renal veins.

The spermatic vessels form around the ovaries a very complex lexus called the *pampiniform body* (*plexus pampiniformis*). They astomose in the substance of the uterus not only those of one side ith those of the other, but those of the upper part with those of the wer.

The nerves of the internal genital parts* come from the ganglion-ary nerve, and those of the external from the iliac plexus.

IV. PROPERTIES AND FUNCTIONS.

§ 2135. As the external genital parts of the female receive a great umber of nerves, they possess an extreme sensibility, which does not xist to the same degree in the internal.

The uterus by its muscular fibres possesses great powers of con-actility, which exist to a certain degree in the vagina also.†

The formation of the new being commences in the ovary.‡

The following facts prove this proposition:—

1st. When extirpated, sterility ensues, although all the other parts emain perfect.

2nd. Of all the parts of the genital system the first changes after productive copulation are observed in them.

3rd. Fœtuses have been found within them

4th. They have also been found in the abdomen, without any trace injury in the parts, and with or without the closing of the tubes.

The tubes receive the product of conception which is developed in e ovary, and carry it into the uterus. This is proved,

1st. By the fœtuses found in the cavity of the abdomen.

* F. Tiedemann, *Tabulæ nervorum uteri*, Heidelberg, 1822.

† Lobstein, in the *Journ. de médecine*, vol. xxxvi., p. 143.

‡ Prevost and Dumas assert (*Mémoire sur la génération dans les mammifères les premiers indices du développement de l'embryon*; in the *Annales des sc. t.*, vol. iii., p. 134) that fecundation does not take place in the ovary, because never find in the pouch covering this organ the spermatic animalculæ, which considered the agents of fecundation; so that according to them the mo-nt of fecundation is much later than that of copulation, and the ovum is not pregnated until arriving in the Fallopian tube or the uterus it comes in con-t with the seminal fluid. How can this theory be reconciled with ovarian gnancy? F. T.

2nd. By those found within the tube, especially in the cases where the external or internal orifice of this passage was obliterated.

3rd. The uterus is the organ in which the new organism is developed.

This proposition is supported by the following arguments:—

1st. The fœtus is developed in the uterus when no anomaly occurs.

2nd. Even when the fœtus is developed out of the uterus, the latter undergoes the usual changes in its substance and its cavity. The possibility of extra-uterine fœtation, however, proves that it is not absolutely necessary to form the new organism.

The vagina is only the conducting organ of the penis, the semen, and the fœtus.

The external parts are the exciting organs, the organs of pleasure, as is proved by their increase of susceptibility before and during coition.

This increase of susceptibility communicated to the internal genital organs and to the organism is attended with the degree of energy or excitement necessary to produce the new being.

B. GENITAL ORGANS OF THE MALE.

I. FORMATIVE ORGANS.

A. TESTICLES.

§ 2136. The most important genital organs in the male are the *testicles* (*didymi*, s. *testes*, s. *testiculi*),* or the glands which secrete the semen.

a. Form and situation.

§ 2137. The *testicles* have an elongated, rounded, and an almost oval form. They are situated at the lower part of the trunk, on the sides and below the penis, in a special fold of the skin which is formed like a sac, and is termed the *scrotum*. They communicate with the parts of the genital apparatus situated within the abdomen, by the *spermatic cord* (*funiculus spermaticus*, s. *testicularis*). This cord is formed by their excretory duct, their vessels and nerves, and the cremaster muscle.

* R. de Graaf, *De virorum organis generationi inservientibus*, Leyden, 1668.—Leal Leali, *De partibus conficientibus in viro*, Padua, 1686. Santorini, *De virorum naturalibus*; in the *Obs. anat.*, cap. x.—J. G. Rœderer, *De genitalibus virorum*, Gottingen, 1758.—J. Wilson. *Lectures on the structure and physiology of the male urinary and genital organs of the human body*, London, 1821.

b. Volume and weight.

§ 2438. The testicle alone, that is its substance, when its envelops, except the most internal, are removed, is generally an inch and a half long, one broad, and about nine lines thick.

It usually weighs about four drachms.

c. Composition.

a. Membranes.

§ 2439. The testicles are surrounded with several superimposed layers, which vary in their nature, and are termed *tunics*.*

1. Skin of the scrotum.

§ 2440. The external layer is the skin of the scrotum, a fold of the common integuments, which descends from the inguinal region, and terminates between the roots of the penis and the perineum. This fold, which is broader at its lower than at its upper part, differs from the rest of the skin, as it is generally a little darker coloured, since it presents distinct hairs, and because there is no fat.

It presents also exactly on the median line a narrow sac, the direction of which is from before backward; this is slightly prominent, and is formed by numerous transverse folds arranged very compactly, and is termed the *raphe*. Although apparently thicker at this part, the scrotum is in fact thinner than in any other.

The epidermis of the scrotum is very solid and thick.

2. Dartos.

§ 2441. Immediately under the skin we find the *dartos* (*tunica carnea*, s. *dartos*), which is situated, in regard to the skin of the scrotum, in the same manner as the adipose substance is in regard to the common integuments, excepting, however, in men who are very fleshy.

It is very vascular, and hence it is reddish, and more or less evidently fibrous. As it is also very contractile, several anatomists, as

* J. F. Neubauer, *De tunicis vaginalibus testis et funiculi spermatici dissertatio*, Giessen, 1767.—A. Monro, *Remarks on the spermatic vessels and the scrotum, with its contents*; in his *Medical essays*, vol. v. pt i., p 205-222.—J. Brugnone, *De testium in fœtu positu, eorum in scrotum descensu, tunicarum quibus continentur, numero et origine*, Leyden, 1788.—P. A. Bondioli, *Sul numero delle tonache vaginali del testicolo*, Padua, 1780.—J. Tumiati, *Richerche anatomische intorno alle tonache del testicoli*, Venice, 1790.

Winslow,* have considered it as muscular, and have compared it to the subcutaneous muscles; but accidental or designed emphysema,† and the comparative results obtained by macerating it and the platisma myoides muscle, show nothing but cellular tissue.‡ Probably, however, it makes the transition from the mucous to the muscular tissue, and there is between it and the other muscles, about the same relation as between it and the muscles of the superior and inferior animals, in whom the fibrous structure is not very distinct, and is concealed in some measure by the gelatine, an element of mucous tissue, which envelops and conceals the fibrin instead of leaving it exposed, as in the superior animals, where even it is not changed into this substance.

§ 2442. The dartos forms two distinct sacs, which are adapted to each other on the median line, and give rise to the *septum of the scrotum* (*septum scroti*), which corresponds to the raphe. It consequently separates the two testicles, not only in respect to position, but also, and to a certain extent, in that of vitality, although they are not perfectly distinct. Like the mucous tissue in general, it is more or less infiltrated with serum.

3. Cremaster muscle.

§ 2443. The *cremaster* muscle, the *fleshy* or *erythroid* tunic (*tunica carnea*, s. *erythroides*), is situated below the dartos; it arises from the horizontal ramus of the pubis, and forms a third layer. This tunic is formed by an external fasciculus, which descends from the lower edge of the two internal broad abdominal muscles, and by an internal fasciculus, which is generally smaller, but is sometimes as large, and rarely larger; this arises from the horizontal ramus of the pubis. It surrounds the spermatic cord, and the internal tunics of the testicle, and is distributed principally on the anterior face, even when it embraces all the surface of the organ. Its fibres describe arches which are convex downward, and separate more from each other the lower they descend.

When there are muscular fibres on the whole surface of the organ, the spermatic cord emerges through the inferior part of the obliquus internus muscle, and not only below its inner edge. Sometimes the internal fasciculus is really or apparently deficient; the latter case is most common. Sometimes in muscular persons, but very rarely, fasciculi leave the cremaster muscle, and go with the spermatic cord into the abdominal cavity.§

This muscle entirely surrounds the cord only at its upper part; below, its fibres separate.

* *Traite du bas-ventre*, § 499.

† Morgagni, *Adv. anat.*, vol. iv. an. 1.

‡ Tumiati, p. 142.

§ Brugnone, *Observations sur les vésicules séminales*; in the *Mémoires de Turin*, 1768, p. 610.—Penchienati, *ibid.*

It is itself enveloped by a prolongation of the thick cellular sheath which surrounds the obliquus abdominis externus muscle, and its fibres, although separated, are united by cellular tissue. This cellular tissue and the cellular sheath which we have mentioned, blend together below, where they alone envelop the testicle, below which they unite with a common vaginal tunic, to give rise to a short but solid tubercle.

This muscle, which is more developed in animals than in man, raises the testicle.

4. Common vaginal tunic of the testicles and spermatic cord.

§ 2444. Next to the erythroid tunic is a layer of mucous tissue, termed the *common vaginal tunic of the testicle and spermatic cord* (*tunica vaginalis testis, et funiculi spermatici communis*). This tunic arises from the mucous tissue which surrounds the peritoneum, and covers the whole cord and testicles: we may by inflating its lower extremity, pass air through the inguinal ring into the cellular layer which covers the anterior and posterior faces of the peritoneum, and even between the layers of the mesentery.

Prolongations proceed inward from the external edge of this layer, and go toward the interior, where they unite together the vessels of the spermatic cord and the vas deferens, but we do not find below it the pretended *proper vaginal tunic of the spermatic cord* (*tunica vaginalis funiculi spermatici propria*), which Neubeauer admits and which he asserts has a distinct cavity, for if after carefully removing this layer from its external surface, the vessels of the spermatic cord be inflated, this air penetrates into every part; and farther, air injected into it, also enters the vessels of the cord. Farther, the common vaginal tunic cannot be considered at its upper part as a special, independent and close serous cylinder, if we reflect, that on removing the cremaster muscle which covers it, it ceases to be impermeable to the air, and that it presents this character only so long as it is surrounded by the muscle and its tendon.

We can at most admit an external layer, similar to the loose layer of the serous membranes, and a reflected fold which surrounds and unites the vessels of the spermatic cord. The first then will be termed the common, and the second the special tunic of the cord.

But below, as far as it covers the proper vaginal tunic of the testicle, this tunic is very firm, evidently fibrous, and adheres intimately to the proper tunic of the gland, especially near its lower extremity.

It is also continuous on the outside in this part with the two tunics which cover it externally.

5. Proper vaginal tunic of the testicle.

§ 2445. We must distinguish from this layer the fifth envelop of the testicle, the *proper vaginal tunic* (*t. vaginalis testis propria*), from which it is perfectly separated.

The tunic is a compound serous membrane. It usually has an oval form, similar to that of the testicle; it however is rather more extensive, so that its cavity is a third higher than the gland, being two inches and a half high. Sometimes a narrower prolongation, which varies in length, leaves the anterior part of its surface, and penetrates below into the common vaginal tunic, and the two cavities uninterruptedly communicate.

We conclude from our dissections, that this prolongation is never detached exactly from its summit, but always a little below it.

The special vaginal tunic receives in its cavity not only the testicle, but also the whole epididymis and a portion of the spermatic cord. At the place where it is reflected on itself, it receives directly these last two parts in the commencement of its internal and reflected fold. When it has enveloped them, it passes on the upper and lower extremity of the testicle, but covers the gland in its greatest portion, so that the summit and the base of the epididymis are only covered by it in the point by which they look toward the testicle. Thence it goes on the whole circumference of the gland. It is by this fold that the spermatic vessels pass to go to the testicle, and enter at its upper and posterior edge.

The two layers which form this fold are slightly united by cellular tissue, so that they are easily separated. It is not difficult to detach the vaginal tunic from the epididymis; but it is less easy to separate it from the testicle, excepting for some lines near the posterior edge.

A portion of this membrane which covers the testicle, has been improperly termed by Tumiati,* the *conjunctiva*. It is usually called the external layer of the tunica albuginea, a term still more inconvenient.

6. Fibrous or albugineous tunic.

§ 2446. The *fibrous* or *albugineous* membrane (*T. albuginea, anonyma, fibrosa*) is the last and the most internal tunic of the testicle. It directly envelops the substance of the gland, and determines its form. It is thick, solid, silvery, shining, and fibrous. In fact, it is a fibrous membrane.

It forms a single cavity, and is perforated at its upper extremity for the passage of the seminal ducts, and at the posterior edge for that of the spermatic vessels.

* *Loc. cit.*, p. 146.

b. Substance of the testicle.

§ 2447. On the inner side of the albugineous membrane, to which adheres in great part but slightly, is the substance of the testicle,* soft brownish yellow mass, divided by the blood-vessels of the tunic ito several *lobules* (*lobuli*),† situated one above another. This substance is composed principally of very many minute canals, which re single, and do not ramify and interlace with each other; they are ermed the *seminal canals* (*canaliculi seminales*, s. *vascula serpentina*, *ductus seminiferi*). Each lobule includes one of these canals. Their ircumvolutions, and they themselves, are united very loosely by a fine ellular tissue, so that they may be easily detached. But it is much nore easy to prove by maceration, their very great number, which is bout three hundred. Each of them is about sixteen feet long and $\frac{1}{00}$ broad. If attached to one another, they would consequently xtend about five thousand feet.

§ 2448. These canals unite near the upper extremity of the testile, into several larger canals, which pass through the albugineous unic, and soon produce about twenty others, which are still larger, alled the *vasa efferentia*. These latter are united in a single fasciulus by a mucous tissue, wind around from below upward, and form ne rounded and enlarged head of the epididymis.

B. EPIDIDYMIS.

§ 2449. The *epididymus* ‡ is the commencement of the excretory uct of the testicle. It begins at the upper extremity of this gland y a thicker, enlarged, and rounded part, called the *head*, and deends along its posterior and upper edge. The fasciculi which forms ne seminal passages, are still separated in the head of the epididyis, although, according to our observations, this part seems to be erforated, even at its upper extremity, only by a simple and very ortuous canal, into which the seminal passages severally open.

The thinnest and longest part of the epididymis, that termed its ail (*cauda*), is a simple, but very tortuous canal; it is at first very arrow, but gradually enlarges very much, and becomes more tortuus. It is but loosely attached to the proper vaginal tunic of the tesicle by a fold of this membrane, and is reflected on itself from below pward at its lower extremity, and is then called the *ductus deferens*. It is about thirty feet long.

* A. Haller, *De vasis seminalibus observationes*, Gottingen, 1745.—A. Monro, *escription of the seminal vessels*; in the *Edinb. essays, phys. and literary*, vol. i. vi.—Id., *De testibus et de semine in variis animalibus*, Edinburgh, 1755.—Id., *Of e seminal ducts*; in the *Observations anatomic. and physiol., wherein Hunter's aim to some discoveries is examined*, Edinburgh, 1758.—G. Prochaska, *Beobachungen über die Samengange*; in the *Abhandl. der Jos. Akad.*, vol. i. p. 198-213.

† B. S. Albinus, *De teste humano*; in the *Ann. acad.*, l. ii. c. xii.

‡ B. S. Albinus, *De epididymo*; in the *Ann. acad.*, l. ii. c. vi.

C. DUCTUS DEFERENS.

§ 2450. The *ductus deferens* or *vas deferens*,* ascends along the posterior and upper edge of the testicle, first in a straight line, then obliquely from within outward. It is tortuous at its origin, but soon becomes straight, and joins the spermatic vessels, with which it is united by cellular tissue, to give rise to the spermatic cord. It ascends directly to the inguinal ring; but in this place its direction changes, and it goes from below upward, and from within outward in the inguinal canal, within which we observe the relation we have indicated, between the blood-vessels and the lymphatics, and the ductus deferens. On leaving this canal it crosses the epigastric artery, and ascends directly before it, then turns behind it on the inside, and upward, and thus comes into the abdominal cavity. Thence it leaves the spermatic vessels at a more or less acute angle, goes inward and downward always on the outside of the peritoneum, which covers only its posterior part, and descends into the small pelvis, converging very much toward that of the opposite side.

§ 2451. The ductus deferens is situated in the pelvis, on the posterior face of the bladder.

It dilates and gradually thickens in its course. At its lowest part, which suddenly dilates considerably, it becomes at the same time very tortuous, less so, however, than at its origin, and gives rise on the outside upward and backward, to a great enlargement, to a kind of purse or cul-de-sac, termed the *seminal vesicle.*

Two very different substances enter into its composition. The external, which is about half a line thick, is of a brownish yellow colour, very hard and solid. Very probably it is irritable, although fibres are distinctly seen in it very rarely. Sometimes, however, we have observed circular fibres which it was impossible to mistake.†

The inner substance is whitish, and easily separable from the preceding, with which it is united only by a loose cellular tissue. It is a mucous membrane, a prolongation of that of the urethra. It is smooth in most of its extent, but reticulated below for an inch or two.

D. SEMINAL VESICLES.

§ 2452. The *seminal vesicles* (*vesiculæ seminales*, s. *parastatæ*)‡ are situated one on each side, on the outside of the corresponding ductus deferens. They are also intimately adapted to the posterior face of the bladder, and are covered posteriorly by the peritoneum, which

* B. S. Albinus, *De vasis deferentibus, vesiculis seminalibus, emissariis quibus ad urethram pertinent, ostiolis in capite gallinaginis*; in the *Ann. acad.*, l. iv. c. iii. p. 16.

† Leuwenhock (*ep.* xli.) has seen also longitudinal fibres.

‡ Haller, *Observationes de vasis seminalibus*, Gottingen, 1745.

adheres to them but slightly. Their breadth is, however, slight in proportion to their length, for they are about two or three lines broad, and four or five inches long; but they appear much shorter, as they are very tortuous.

They are, however, not always simply tortuous or similar to a long cul-de-sac, as Lealis, and since his time Caldani,* have asserted. In fact, they more commonly ramify.

Their inner membrane presents numerous inequalities, which produce a kind of net-work with irregular meshes. There is also between the largest folds, a considerable number of less prominent folds, which also render their inner face still more uneven. This arrangement establishes a striking analogy between the seminal vesicles and the gall-bladder.

§ 2453. The lower extremity of the seminal vesicles and of the ductus deferens, opens into an extremely narrow duct some lines long, termed the *ejaculatory duct* (*ductus ejaculatorius*). This duct approaches from behind forward, and from below upward, that of the other side, enters into the substance of the prostate gland, and opens into the urethra, directly at the side of this latter, in the centre of the *verumontanum*.

E. PROSTATE GLAND.

§ 2454. The *prostate* gland (*prostata*) is a triangular† body, usually of the size and form of a chestnut; is about an inch broad, one high, and half an inch thick, and weighs about five drachms.

It is situated below and before the bladder, and surrounds the commencement of the urethra posteriorly and on the sides.

It is whitish, hard, and solid, and it is surrounded by a fibrous and resisting membrane.

It is composed of three tubes, two lateral and a central, which is posterior and smaller.

The middle lobe is situated behind and between the two lateral lobes and the ejaculatory ducts, and likewise between these latter and the bladder; it is rounded and smaller than the lateral; its volume however varies. In the centre of its lower face is an oblong rounded eminence, which terminates anteriorly in a narrow and elongated point. This eminence has been termed from its form, the *verumontanum* (*caput gallinaginis*, s. *verumontanum*, s. *colliculus seminalis*). It presents at its centre one or two orifices of the ejaculatory ducts, and on the sides a considerable number of orifices leading to the excretory canals, which are distributed in the substance of the gland. These orifices give passage to a yellowish fluid, the *fluid of the prostate*, which mingles with the semen at the time of emission.

* F. Caldani, *Opusc. anat.*, Padue, 1803.
† Home, *On the prostate gland.*

The excretory ducts of the middle lobe pass immediately through the membranes of the bladder, behind and on the outside of the verumontanum.

II. ORGANS OF COPULATION OR PENIS.

A. FORM AND SITUATION.

§ 2455. The *penis* (*penis*, s. *coles*, *priapus*, s. *membrum virile*) is situated forward, and entirely on the outside of the pelvis, below the symphysis pubis, between the thighs. Its form is nearly cylindrical. The common excretory duct of the urine and semen, the *urethra*, passes through it.

It is entirely surrounded by a prolongation of the skin, which in this place is thin and destitute of hairs, and fat. External examination shows even through the skin, that it suddenly enlarges at its anterior extremity, where it presents a considerable prominence, and that it terminates in a blunt point.*

a. Glans.

§ 2456. This enlarged portion is the *glans penis*,† a rounded triangular body, terminated posteriorly by a rounded sac, termed the *crown* (*corona glandis*), which entirely surrounds it, and forward by a longitudinal groove, the external orifice of the urethra. The contracted portion, situated behind the glans, is its *neck*.

The glans is not exposed ; it is covered by three layers of skin.

b. Prepuce.

§ 2457. The first two layers are united by cellular tissue, so that the external is turned outward, and the internal inward. They form the *prepuce* (*preputium*). This fold is fitted to the glans, but is not attached to it, so that it can be drawn backward and forward ; the first motion exposes the glans, the second covers it.

The internal layer of the prepuce is soft, reddish, moist, and similar to a mucous membrane.

In the centre, where the two layers are continuous with each other, the prepuce presents apparently a rounded opening, which corresponds

* F. Ruysch, *Responsio*, &c. in the epist. xv. *De vas. sanguineorum extremit.*, &c. *hisce accedunt nonnulla circa penem detecta.*—B. S. Albinus, *De Ruyschiano involucro penis externo, et de tunica cellulosa penis*; in the *Ann. acad.*, l. ii. c. xi.—F. Ruysch, *De involucro penis externo*, ibid. l. ii. c. xiii.—L'Admiral, *Icon penis humani cera præparati*, Amsterdam, 1741.—J, H. Thaut. *Diss. de virgæ virilis statu sano et morboso*, Wurzburg, 1808.

† F. Ruysch, *Glandis in pene vera structura noviter detecta* ; in the *Obs. med. chir.*, cap. c.—B. S. Albinus, *De integumentis glandis penis* ; in the *Annot. acad.*, lib. iii, c. i

o the anterior orifice of the glans, and which disappears when the repuce is drawn entirely backward. The latter is corrugated transersely in the same proportion.

The internal layer of the prepuce is reflected a second time behind he glands, but here from behind forward, and covers the organ, ntimately adhering to its tissue. This adhesion is almost gradual n the circumference of the glans. In fact the internal fold of the repuce is loose at its upper part, where it is attached but feebly to ne penis; but near the centre of its lower part, it is tense, short, and ntimately united to the corresponding portion of the glans, and forms short perpendicular fold.

This portion of the prepuce is termed the *frenum of the glans* (*freulum glandis*).

All around the neck and posterior face of the crown, the most interal cutaneous fold of the glans presents numerous rounded depresions, termed the *glands of Tyson* (*glandulæ Tysonianæ*), which serete a thick and whitish fluid.

This fluid (*smegma præputii*) has a disagreeable smell, and tends ery much to solidify.

B. SIZE OF THE PENIS.

§ 2458. When not erected, the penis is about three or four inches ng and one inch thick.

C. COMPOSITION.

§ 2459. The penis is attached to the skin, which covers it only ry loosely.

It is composed of a thick and fibrous membrane, which determines s form, and of a spungy tissue, principally formed by dilated veins, hich is then divided into three distinct bodies. The two upper and teral are termed the *cavernous bodies of the penis* (*corpora spongiosa, cavernosa, s. nervosa penis*), the inferior is termed the *spungy body the urethra* (*corpus spongiosum, s. cavernosum urethræ*).

The cavernous bodies of the penis and urethra are generally deribed as a collection of different cellules of the vessels; but these llules are in fact only dilated veins, and the spungy bodies are comsed of a very complex net-work of arteries and veins, as Vesalius* d Malpighi† had already stated generally in regard to the penis, d Hunter,‡ of the spungy body of the urethra particularly.

* *De corporis humani fabricâ*, lib. v. c. xiv. *Corpora hæc.. enata ad eum fere dum, ac si ex innumeris arteriarum venarumque fasciculis quam tenuissimis, silque proximè implicatis, retia quædam efformarentur, orbiculatim à nervea membraneaque substantia comprehensa.*

† *Diss. epist. varii argumenti*; in the *Opp. omn.*, vol. ii. p. 221. *Sinuum spem in mammarum tubulis et in pene habemus; in his nonnihil sanguinis repeur, ita ut videantur venarum diverticula, vel saltem ipsarum appendices.*

‡ Hunter, *Obs. on certain parts of the animal economy*, p. 43.

This structure had been perfectly demonstrated in the penis of the large animals, as the elephant and the horse, partly by Duvernoy,* but particularly by Cuvier † and Tiedemann ;‡ in the penis of man by Ribes,§ Moreschi, an dPanizza.

a. Cavernous bodies of the penis.

§ 2460. The *cavernous bodies of the penis* form most of the member, that is, its upper parts and its sides. They are more broad than high.

They alone have evidently a fibrous envelop, the fibres of which interlace with each other and are longitudinal.

They arise on each side by a branch about half an inch long, which comes from the ascending ramus of the ischium ; the two branches ascend to meet each other, and unite before the symphysis pubis, where they are surrounded in their whole circumference by a common envelop.

Although they appear simple externally, these bodies are however imperfectly divided into two halves, a right and a left, by a *perpendicular septum* (*septum corporum cavernosorum*), which extends almost their whole length, and is a prolongation of the external fibrous membrane. This septum is formed of very long fibres, compressed from right to left, which extend the whole length of the cavernous bodies, and which, forming posteriorly an almost perfect septum, proceed forward, growing thinner, and diminishing much in number, so as to leave between them greater or less spaces. The separation which takes place between the two cavernous bodies at their posterior extremity, then gradually disappears forward entirely. They, however separate still more at their anterior extremity, although apparently only on the outside, since the external part of their circumference is much longer than the internal, whence their anterior faces, surrounded by the external tunic, unite from without inward at a re-entering angle.

b. Urethra.

§ 2461. The *urethra* ‖ proceeds along the lower face of the penis. It begins in the prostate gland, where it is broad. In front of this

* *Comm. Petrop.* a. ii. p. 400. *Venarum ductus solummodo cribiformes, foraminibus undique pertusi ac reluti erosi, a cellulis ægre discriminandi extra capsulam penis, venaram* (s. *brevium tubulorum verticalium*) *formam inducentia, in conspectum veniunt.*

† *Anat. comparée*, vol. iv.

‡ F. Tiedemann, *Notice sur les corps caverneux de la verge du cheval, suivie de quelques réflexions sur le phénomène de l'érection*; in the *Journ. compl. des sc. méd.*, vol. iv. p. 282.

§ *Exposé sommaire de quelques recherches anatomiques, physiologiques et pathologiques* ; in the *Mém. de la soc. méd. d'emul.*, vol. vii. p. 605.

‖ A.Littre, *Description de l'urètre de l'homme*, in the *Mém. de Paris*, 1700 —J. P. Werne, *Structura urethræ*, Leyden, 1752.

point it contracts much for about an inch, so as to be only one or two lines in diameter. This contracted portion is called the *isthmus of the urethra* (*isthmus urethræ*). It ascends a little obliquely from below upward, and from behind forward, below the symphysis pubis, from which it is about an inch distant, surrounded by a loose spungy tissue, like the urethra in the female, which corresponds only to this portion of the urethra in the male. The canal afterward enlarges very much, and is then surrounded in the rest of its extent by the cavernous body of the urethra, the size of which is generally in direct ratio to its diameter.

The cavernous body of the urethra is largest at the second prominence, where it forms a considerable enlargement, called the *bulb of the urethra* (*bulbus urethræ*).

On leaving this point the urethra contracts very much. Its diameter continues about the same to the anterior extremity of the penis; but directly behind and within the glans it enlarges a third time to form the *navicular fossa* (*fossa navicularis*).

The cavernous body of the urethra is enveloped only by a dense cellular tissue, which is not fibrous. It is finer, and of a more delicate tissue than that of the penis, and has no septum. It alone forms the glans anteriorly.

Below this body is a thin and reddish mucous membrane, which is united intimately with it, and has longitudinal folds.

This membrane presents numerous cavities arranged successively as culs-de-sac in a single series, termed the *glands of Littre*.

These cavities are sometimes three lines deep. They are seen only at the lower part of the circumference of the urethra, and their direction is such that their orifice looks forward and their cul-de-sac backward*.

* As Ducamp's researches have reduced the treatment of strictures of the urethra almost to mathematical accuracy, it is necessary to have a more extensive knowledge of this canal than has been given by Meckel. This may be found in a memoir of Amussat (*Remarques sur l'urètre de l'homme et de la femme*; in the *Archiv. gén. de méd.*, vol. iv., p. 31 and 347), who has ascertained a very important practical fact, that even in young subjects the urethra is straight or nearly straight when the rectum is empty, and the penis is directed from before backward. We distinguish in it three portions; the *prostatic* portion, with thin parietes, which is enveloped by the prostate gland; it is about twelve or fifteen lines long; the *membranous* portion, the parietes of which are a little thicker; it is from nine to twelve inches long; and the *spungy* portion, which is from about six to seven inches long. Most authors consider the whole canal as ten or twelve inches long; but it is only nine, and very frequently, at least sometimes, even less than eight, as has been stated by F. Whately (*An improved method of treating strictures in the urethra*, London, 1816, p. 68). We may then estimate its mean length as between eight and nine inches, nine inches and six lines and seven inches and six lines being the two extreme proportions observed by Whately in forty-eight different subjects. It is not equally broad in every part. It follows, from Sir E. Home's researches (*Practical observations on the treatment of strictures in the urethra*, London, 1805. vol. i., p. 24), that its diameter is four lines in most of its extent, and that its external orifice is at least one line narrower, since it is only from two and a half to three lines in diameter. Amussat has since proved that the urethra, when the parts which cover it are removed

c. Cowper's glands.

§ 2462. Besides the testicles and the prostate gland, we also frequently, but not always, find two or three other small, yellowish, oblong, rounded, hard glands, formed of several lobes enveloped by a very dense aponeurotic sheath. These glands are about the size of a large pea, are situated directly below the upper part and a little before the prostate gland.

Their ducts are about an inch and a half long, go forward in the bulb of the urethra, and open form below upward in the sides of this canal by distinct orifices.

The two posterior lateral are termed the *glands of Cowper.** The anterior, which is unmated, is smaller and much less constant than the other two; it is termed the *anterior prostate* gland (*antiprostata.*)

D. MUSCLES OF THE PERINEUM.

a. Special muscles of the penis.

§ 2463. The penis has three muscles, one of which, the *ischio-cavernosus*, belongs to the cavernous bodies of the penis, the second, the *bulbo-cavernosus*, belongs to the spungy body of the urethra, while the third, the *constrictor urethræ* muscle, moves the membranous portion of this canal. All three are situated at the extremity of the penis.

a. Ischio-cavernosus.

§ 2464. The *ischio-cavernosus* muscle, *ischio-uretral*, Ch. (*M. ischio-cavernosus*, s. *erector penis*), resembles that of the clitoris in its origin, attachments, direction, and mode of action; but it is much larger, and sometimes arises by a second head from the sciatic tuberosity.

and it is reduced almost to the mucous membrane, represents a cone, the base of which is turned backward, and which is slightly prominent at its membranous portion, contracts opposite the bulb to enlarge suddenly at the commencement of the spungy portion, and diminishes imperceptibly to the meatus, so that there is no enlargement in the place corresponding to the glans, that is, in the navicular fossa. Amussat explains the appearance of an enlargement in this latter point, by saying that the tissue of the glans is less soft and the mucous membrane is attached to it more intimately, so that in dividing the urethra, the two halves of the glans remain firm and distinct, while the proper spungy tissue contracts and collapses, being freed from the blood within it. That the navicular fossa is only apparent is proved by extending transversely the spungy portion behind the glans, when it becomes as broad as that situated in the body. He has also given a very exact plate of the urethra (*loc. cit.*, pl. iii., fig. 1 and 2). F. T.

* G. Cowper, *Glandularum quarumdam, nuper detectarum descriptio*, London, 1702.—L. Terranus, *De glandulis universim et speciatim ad urethram virilem novis*, Leyden, 1729.—G. A. Haase, *De glandulis Cowperi mucosis*, Leipsic, 1803.

b. Bulbo-cavernosus.

§ 2465. The *bulbo-cavernosus* muscle, *bulbo-uretral*, Ch. (*M. acce-erator urinæ*, s. *bulbo-cavernosus*), is thin, flat, and nearly rhomboidal. .t surrounds the bulb and the posterior part of the urethra. It arises orward from the posterior part of the cavernous body of the penis, .nd backward from the upper part of the lateral wall of the bulb of he urethra. It terminates anteriorly by a straight edge, which de-.cends from without inward and from before backward, and posteriorly y a rounded edge. It is formed at its anterior part by very oblique ibres, and at its posterior part by fibres which are nearly transverse. t blends on the median line with that of the opposite side so inti-nately, that frequently they are not separated by a median tendinous .ine.

c. Constrictor urethræ.

§ 2466. The *constrictor urethræ* muscle, *pubo-uretal*, Ch. (*M. onstrictor urethræ*, s. *pubo-urethralis*),* is elongated, quadrilateral, nd flattened from without inward. It arises by a short tendon a ttle above the lower edge of the symphysis pubis, some lines below he tendinous attachment of the bladder, directly at the side of the endon of that of the synonymous muscle, on the inner face of the ymphysis. Thence it descends enlarging, is first next that of the pposite side, but removes from it on arriving at the membranous ortion of the urethra, to which it is attached, and below which it s blended with its synonymous muscle, so that generally only a ten-.inous line, corresponding to the median line, indicates their sepa-ation.

It usually blends at its anterior extremity with the posterior extre-nity of the bulbo-cavernosus muscle.

It is frequently united at its lower part by some fibres to the levator ni muscle; but in the rest of its extent it is separated from it only y veins, which arise from the prostate gland and the bladder, pro-eed from behind forward, and empty into the great dorsal vein of he penis.

The two muscles form a ring around the membranous portion of he urethra; they compress it, and by their convulsive contractions ery much increase the difficulty of passing a sound through this por-ion of the canal.

* Wilson, *Description of two muscles surrounding the membranous part of the rethra*; in the *Med. chir. trans. of London*, vol. i., p. 175.

b. Common muscles of the genital parts, the rectum, and the urinary passages.

a. Transversi perinei.

§ 2467. We usually find two muscles on each side, the *transversi perinei* muscles, *ischio-perineal*, Ch., which go inward from the ischium and the pubis, and which are similar, as they are both long.

§ 2468. The *posterior* and *inferior* arises from the inner face of the sciatic tuberosity, goes from without inward and from behind forward, and blends particularly in the female with that of the opposite side and with the anterior extremity of the sphincter ani externus muscle, and slightly also with the posterior extremity of the bulbo-cavernosus and the constrictor vaginæ muscles.

In acting with its synonymous muscle it draws the anus a little backward and compresses it from before backward, and thus favours the expulsion of the fæces.

§ 2469. The *anterior* and *superior* arises from the inner face of the lower part of the descending ramus of the pubis, where it is frequently united intimately to the preceding, goes inward and a little forward, blends again with the preceding, that of the opposite side, and the sphincter and externus muscle, and likewise with the bulbo-cavernosus and the constrictor vaginæ muscles, farther than that we have mentioned.

It acts like the posterior, but it also contributes to open in the male the posterior part of the urethra, and in the female the vagina.

§ 2470. The posterior transversus perinei muscle is frequently deficient. In man the two muscles are much nearer each other and much slighter than in the female. In the latter we sometimes find a third, situated between the other two.

b. Levator ani.

§ 2471. The *levator ani* muscle, *sous-pubio-coccygien*, Ch., is broad, thin, and semicircular. It arises forward and upward from the lower part of the symphysis pubis and the horizontal ramus of the pubis; it also comes from the inner face of the body of the ischium to the sciatic spine, above and on the inside of the upper edge of the obturator internus muscle. Thence it goes inward, downward, and backward, so that its anterior fibres are almost perpendicular and the posterior transverse.

It passes behind the lower part of the rectum, and is attached by short tendinous fibres to the lateral edge of the three lower pieces of the coccyx by the posterior part of its inner edge, while by the anterior it blends with that of the opposite side.

It follows from this arrangement that the two muscles form a large ring, which surrounds the lower extremity of the rectum posteriorly,

and which in the female is attached very intimately to the vagina before arriving at the rectum.

In the female the anterior part which arises from the spmphysis pubis is often separated from the rest.

This muscle raises the lower part of the rectum, contracts it, and thus prevents the prolapsus of the intestine, also favours the expulsion of the fæces; carries forward and upward the coccyx, which has been pushed forward by the fæces and excrements, and by the fœtus in parturition, favours the expulsion of the urine and semen by compressing the bladder and seminal vesicles, and finally prevents prolapsus of the vagina in females.

III. VITAL PROPERTIES AND FUNCTIONS OF THE GENITAL ORGANS IN THE MALE.

§ 2472. The testicles secrete the semen, and are the most important part of the genital organs, since the action of this fluid on the body of the female can alone cause the formation of a perfect new organism.

This is demonstrated by sterility occurring when these organs are extirpated, are congenitally absent or diseased, although the other genital organs are formed normally.

The semen is a whitish and strong smelling liquid; it is composed in 1000 parts: of water 900, animal mucilage 60, phosphate of lime 30, soda 10.*

The testicles also perform an important part in the individual organism; for when they do not exist, or when they have been removed, the body and the mind vary more or less from the normal state, the larynx and the voice are not developed, the beard does not grow, in short the individual does not acquire the distinctive characters of his sex.

The semen is carried from the testicles through the ductus deferens into the seminal vesicles, where, like all the other fluids in their reservoirs, it continues a certain time, becomes perfect, and is concentrated by the absorption of its aqueous portion,† and perhaps is somewhat modified by mingling with a fluid secreted in the parietes of the vesicles.

In fact, several distinguished anatomists, as Wharton,‡ Van Horne,§ Swammerdam,|| and Hunter¶, have rejected this gene-

* Vauquelin, *Annales de chimie*. vol. ix., p. 64.—Berzelius states (*Annales de chimie*, vol. lxxxviii., p. 115) that the semen is formed of a peculiar animal matter and of all the salts of the blood.

† G. Eltner, *Semen non resorbetur*, Berlin, 1820.

‡ *De vesiculis seminalibus*; in his *Adenographia*, cap. xxx., p. 208.

§ *Prodromus observationum suarum circa partes genitales in utroque sexu*, Leyden, 1668.

|| *Miraculum naturæ*, s. *uteri muliebrus natura*, Leyden, 1672, p. 10.

¶ *Observations on the glands situated between the rectum and bladder, called vesiculæ seminales*; in the *Observations on certain parts of the animal economy*,

rally admitted opinion, and assert that the seminal vesicles do not receive the semen, but they only secrete a peculiar fluid supplied by the testicles, and some of them, as Wharton, have considered it as the proper semen. They adduce the following arguments:

1st. The seminal vesicles and the ejaculatory ducts have no common excretory canal.*

2nd. Their structure is glandular.†

3rd. A liquid injected to the base of the seminal vesicle penetrates into the ductus deferens.‡

4th. Several animals, particularly fishes, have seminal vesicles, but no testicles.§

5th. The fluid contained in the seminal vesicles differs from the semen, both in man and animals; it is much brighter and more liquid, and has not the peculiar odour of semen.||

6th. The fluid which sometimes comes from the urethra, when violent efforts are made at stool, is very similar to that found in the vesicles.¶

7th. In males who have lost one testicle,** or in whom one of the testicles does not communicate with its seminal vesicle, this latter and even the lower part of the ductus deferens of the same side have been found not contraced or empty, but, on the contrary, larger and fuller than that of the opposite side.††

8th. When coition is interrupted, pain is felt in the testicle, and not in the seminal vesicles.‡‡

9th. The seminal vesicles are as full in aged men and those who have long been indisposed, as in those who die suddenly, or as in young men.§§

10th. In several animals there is no communication between the seminal vesicles and the vasa deferentia.||||

11th. In many animals, particularly in guinea-pigs, the seminal vesicles are filled with fluid after coition.¶¶

12th. We find no traces of them in several animals.***

§ 2473. Many of these facts, however, are but slightly conclusive,

London, 1786, 1792, p. 31.—Chaptal, *Mém. où l'on se propose de faire voir que les vésicules séminales ne servent pas de réservoir à la semence séparée des testicules*; in the *Journal de physique*, 1787, p. 101.

* Wharton, p. 209.—Van Horne.

† Ibid.

‡ Swammerdam, *loc. cit.*, p. 10.

§ Idem, in Brugnone, *Mém. de Turin*, 1786, p. 619.

|| Hunter, p. 32, 38, 39.

¶ Id., p. 33.

** Id. p. 33-36.

†† Id., p. 37.

‡‡ Id., p. 37.

§§ Id., p. 37-38.

|||| Id., p. 38.

¶¶ Id., p. 39.

*** Id., p. 40.

r are even incorrect, so that they may be easily refuted, and the old pinions thus be maintained.*

1st. The seminal vesicles and the vasa deferentia communicate in he manner mentioned above.

2nd. The glandular structure of the vesicles only proves that they ecrete, and not that they receive semen.

3rd. The facility with which liquids injected into them penetrate nto the ductus deferens proves exactly that with which the semen rom these latter within them.

4th. The organs of fishes said to be seminal vesicles are in fact esticles.

5th. The difference between the liquid in the vesicles and the semen mitted, may depend on a mixture of their proper secretion with that f the testicles. Farther the semen ejaculated is composed of the fluid f the testicles united with that of the seminal vesicles, the prostate land, the glands of Cowper, and the mucous membrane of the rethra.

6th. It does not follow from this that the liquid ejaculated has not assed from the testicles into the seminal vesicles. Possibly, the fluid xpelled during efforts to go to stool, comes from the prostate gland nd even from other parts, as a similar thing occurs in dogs which ave no seminal vesicles.†

7th. Possibly this effect was accidental, which is more probable, ince the gall-bladder, when the bile is prevented by a calculous form ntering, is often distended to a great degree by the mucous which it ecretes.

8th. This opinion is often opposed, at least by experience. Farther, hen this is not the case it would only prove that the venereal or- asm increases also the action of the testicles, and that the semen mitted comes not only from the vesicles, but also from the glands hemselves.

9th. The assertion is not correct, and proves nothing. Even Hun- er admits that the seminal vesicles take part in the genital act, so hat their uniform depletion under different circumstances is not more urprising, whether the fluid comes from the testicles, or is secreted y the vesicles.

10th. The absence of the seminal vesicles in several animals, does not prove that the semen is not introduced into the reservoirs when hey exist. Farther, a communication between the vesicles and the asa deferentia, really exists in several animals where it is not admit- ed by Hunter, as the guinea-pig and the horse, while the pretended

* De Graaf, *Partium genitalium defensio*, Leyden, 1673.—Needham, Croone, nd King, in Birch., *Hist. of the roy. society*, vol. iii., p. 103.—Brugnone, *Obser- ations anatomiques sur les vésicules séminales tendantes à en confirmer l'usage*; n the *Mém, de Turin*, 1786-1787.—Sœmmerring, *Anmerkungen über Hunter's Aufsatz*; in Blumenbach, *Medic. Bibl.*, vol. iii., p. 87.

† Brugnone, *loc. cit.*, p. 622.

seminal vesicles, which according to others do not communicate with the excretory passages of the vesicles, are prostate glands.

11th. There is no proof that a portion of the contents of the seminal vesicles does not escape during coition.

12th. It does not follow that the semen does not run at all in the seminal vesicles in those animals which are provided with these reservoirs.

13th. In whatever position the body may be, the liquid injected through the ductus deferens, arrives sooner into the vesicle than into the ejaculatory passage.*

14th. The substances injected into the vesicle generally emerge through the ejaculatory passages before arriving at the ductus deferens, and frequently do not penetrate at all into the latter.†

15th. The air and sounds introduced through the orifice of the ductus deferens, easily penetrate into the vesicle, but with difficulty into the ejaculatory passage. Notwithstanding this refutation of Hunter's opinion, we cannot deny that the proper secretion of the seminal vesicles seems to contribute powerfully to elaborate the semen.

§ 2474. The semen comes into the urethra and directly into the prostate gland, where it mingles with a more serous and yellowish white fluid secreted by this gland, and which also contributes to perfect it.‡

On leaving this point it is sent into the penis by the action principally of the bulbo-cavernosi muscles.

§ 2475. The penis possesses in a great degree the power of enlarging and lengthening by the excitement of the venereal passion. It also becomes hard and stiff, which depends undoubtedly on the dilatation and tension of its fibrous envelop.

Its power of erection depends on the peculiar arrangement of its vessels; when erected it can enter into the vagina of the female; it fills this canal more or less perfectly, and injects the semen into the internal organs of generation, particularly the uterus. The erection of the penis depends on the great excitement of the nervous action, either in the whole system or in the nerves of the penis, which are proportionally very large; a greater quantity of blood is then carried into it by the arteries, and is not resumed by the large and numerous veins of the organ, as rapidly as it flows into it. It has been asserted that the phenomenon of erection ought not to be explained thus by the accumulation of blood, but this opinion is completely refuted by the experiments,‖ in which, on cutting the penis when erected, after tying its base, the venous plexuses are found gorged with blood.

* De Graaf, *loc. cit.*, Brugnone, p. 620.

† Brugnone, *loc. cit.*

‡ Haller, *El. phys.*, vol. viii., p. 454.—Brugnone, *loc. cit.*

§ Langguth, in Schumann, *De vi imaginations in fœtum*, Wittemberg, 1790.

‖ R. de Graaf, *De virorum organis*; in *Opp. omn.*, p. 84.—Swammerdam, *Prodr. obs. de part. genit.*, p. 13.—Th. Roose, *Ueber das Auschwellungsver-*

§ 2476. The first changes which cause the emission of semen, un-
ubtedly take place in the glans, since it possesses the most nerves,
id is the most sensible part, not only of the penis, but of the whole
nital system. The excitement of the nervous action in this part
extended to the whole nervous system, particularly to the nerves
the genital organs, quickens the secretion of the testicles, the se-
inal vesicles, and the other glands, and causes convulsive motions
the bulbo-cavernosi muscles, which compress the spermatic fluid
ien it arrives at the posterior part of the urethra, and throw it by
s into this canal, which is rendered straight by the erection of the
nis.

II. MAMMÆ.

§ 2477. The *mammæ** are the accessory parts of the genital sys-
n, which in man and in all true mammalia, establish a natural
ation between the organism of the mother and that of the child, by
ans of the milk which they secrete, which continues during the
rly periods of life. In birds, and perhaps also in some reptiles,
re exists a similar connection between the mother and the off-
ring, which continues a longer or shorter period after the birth of
latter. But in these animals it does not occur by a special
an, having the power of secreting a peculiar nutritious fluid. It
nly by a portion of the intestinal canal, the *crop* (*ingluvies*), which
dergoes about this period a change analogous to that which occurs
the mammæ, but which, however, serves for the mother and the
spring.

I. NUMBER.

§ 2478. The mammæ are two in number; they are glandular
gans, conglomerate glands.

Although, regularly, they fulfil their function only in the female,
y occur also in the male, where they are much developed; the
mmæ of the male, however, are sometimes as large, and their
retion as abundant as those of the female.

gen des männlischen Gliedes im gesunden Zustande; in *Physiologische Unter-
hungen*, Brunswick, 1796, p. 17.

A. Nuch, *Adenographia curiosa*, Leyden, 1691., c. ii.—Mencelius, *De struc-
a mammarum*, Leyden, 1720.—Guntz, *De mammarum fabrica et lactis secre-
e*, Leipsic, 1734.—Bœhmer, *De ductibus mammarum lactiferis*, Halle, 1742.—
lpin. *De structura mammarum*, Gripswald, 1764.—Crusius, *De mammarum
ica et lactis secretione*, Leipsic, 1785.—Covolo, *De mammis*; in Santorini,
ul. septemd., p. 92-110.—Girard, *De mammarum structura*; ibid., p. 110-116.
, Joannides, *De mammarum physiolo*[illegible] Halle, 1801.

II. SITUATION AND FORM.

§ 2479. They are situated opposite to one another, one on each side, on the anterior face of the chest, and the region which they occupy in the female is termed the *mammary* region (*regio mammæ*). The glandular substance which forms their base, is surrounded by a great quantity of fat, which gives them a semicircular form. Their base, however, is not perfectly circular, but rather elliptical.

It extends particularly upward and outward, and often to the region of the axilla; it is more circular below and inward. It extends from the third to the seventh rib, and covers most of the pectoralis major muscle; but not unfrequently the most external portion of its lower edge covers also a portion of the serratus magnus muscle.

The edge of the mammæ is not smooth in every part, nor is its thickness uniform. In those females who have borne several children, it presents inequalities, because the gland enlarges irregularly outward, so that irregular prolongations leave its edge.

Nor is the circumference of the mammæ smooth in every part.

It presents in every part analogous prolongations, differing in form, size, and direction, which render its surface uneven, and leave between them greater or less depressions. The lower and internal part of these glands is much thicker than the upper and external.

A little below the centre of the mammæ, in its thickest portion, we perceive a more or less prominent eminence, termed the *nipple* (*mamilla, papilla mammæ*), which is surrounded by a more coloured circle, and the level of which is often below that of the common integuments. This circle, the skin of which is thinner and finer than that of the rest of the nipple, is termed the *areola* (*areola mammæ*).

III. TEXTURE.

§ 2480. The texture of the mammæ is not the same in every part. Almost all its substance is composed of small reddish white *grains* (*acini*), which are distinguished very easily in females during the period of lactation. These grains are about the size of a millet seed. They are composed in turn of smaller vesicles, not rounded, but oblong, which are grooved and ranged in rays. They are united by cellular tissue and vessels.

These grains do not exist toward the centre, in the areola, where we find only a fibrous and whitish substance, which is decomposed by maceration, into a tissue of canals, which are united by cellular substance.

§ 2481. These canals are the extremities of the *milk-ducts* (*ductus galactophori, s. lactiferi*). The latter arise by as many small roots as there are grains, and gradually unite in larger trunks, which finally terminate in the centre of the nipple, behind the areola, by conical

lilatations or sinuses. The excretory passages of the mammary gland are larger than in any other conglomerate gland. The size of the runks varies according as they receive a greater or less number of branches. Many are very small. The number of great branches which finally unite to give rise to one trunk, varies from four to twelve. The extent of the central sinus is also in direct ratio with the size of the trunks. Sometimes these dilatations are from two to three lines broad; but they are always short, compactly arranged at their internal extremity, and a little separated at their external. The internal extremity of each suddenly contracts into a very small canal, which passes in a straight line through the centre of the nipple to its summit, contracts a little, rarely enlarges in some part of its extent, and finally opens on the surface of the nipple by a very small orifice. All these small canals, which are about the breadth of a finger long, are united very intimately by mucous tissue. Only one canal comes from each dilatation.

§ 2482. The whole milk-passage, which consequently includes the carrying portion, the dilatation, and the excretory canal, is formed by a soft, thin, and transparent membrane, similar to a mucous membrane.

These passages are not exposed in most of their course. The trunks are often situated very deeply in the substance of the gland, and those even which proceed at first on its surface, especially those which come from the prolongations mentioned above, penetrate deeply. They are formed by the successive union of branches and twigs, which always diminish in calibre; but they do not communicate by anastomosing branches. Nuck* and Verheyen† have in fact described and figured very large anastomosing branches, situated in the areola, directly at the base of the nipple, which go from one milk-passage to another, and thus form a ring; but no other person has found them, and we also have been unsuccessful, although we have carefully sought for them several times. This anastomosing circle is not only invisible, but also the injection pushed into one milk-passage never flows into another, which would be the case if the anastomoses really existed. The milk-passages are not provided with valves as several observers have stated. Farther, the existence of these valves is refuted by the facility with which injections enter through the nipple. Sometimes, however, we observe fluids, particularly mercury, injected through an opening in one milk-passage, return by another, but always under circumstances which prove the communication exists between the most minute ramifications of the passages. Probably the anastomoses, like the ducts themselves, do not dilate sufficiently to produce this result until toward the end of pregnancy, and during the period of lactation. But the researches of Meckel‡ on the mammæ

* *Adenographia curiosa*, Leyden, 1691, p. 16, fig. 2.
† *Anat. corp. hum.* vol. i. tab. xviii. fig. 4.
‡ J. F. Meckel, *Nova experimenta et observat. de sinibus venarum*, Berlin, 1772, p. 5, 9.

of females dying in parturition, demonstrate their existence as positively, as it refutes that of the anastomoses admitted by Nuck and Verheyen. We have also obtained the same results under similar circumstances.

§ 2483. Notwithstanding these small anastomoses, the mammæ is composed of as many distinct and separate glands as there are milk passages. This is demonstrated by injecting each canal with differently coloured fluids, for the injections blend in no part, and the different glands can be detached and separated.

§ 2484. The number of the milk-passages, consequently also that of the conglomerate glands, varies even in the two mammæ of the same female. The old anatomists have reduced the number too much, as they estimated them only at six or seven; Haller, Walter, Covolo, and ourselves, have never found less than fifteen. Our dissections, however, have convinced us that Walter was mistaken in saying that there are never more than fifteen, sometimes we have found more than twenty, as have also Haller and Covolo. Their greatest number is twenty-four, according to Covolo. These that are situated highest, and most on the outside, are, as Walter justly remarks, very small and very narrow, which agrees with the less degree of thickness of the mammary gland at its upper part.

§ 2485. Besides the orifices of these milk-passages on the summit of the nipples, we find in the areola also, others which generally occupy the extremities of the tubercles; these are arranged irregularly, and two or three of them sometimes unite in one.

Several anatomists have considered these tubercles as simple sebaceous glands. Bidloo and Morgagni have sometimes seen coming from them a limpid liquid; Morgagni, Winslow, and Covolo have also seen them supply a more or less thick milk in females, during lactation, and the last phenomenon has been observed also in males by Morgagni. The quantity and the nature of the fluid coming from them, depends on the length of time which has elapsed between the repast and the time of nursing, so that several hours after the repast, or when the child has not been nursed for a long time, the milk is abundant, while in the opposite case, some drops of a brighter liquid slowly dribble out.

These tubercles are entirely different from sebaceous glands. We find numerous sebaceous glands on the areola and the nipple, and they never rise above the surface like the tubercles, on which we often observe several. An attentive examination shows in several of these tubercles, one, and sometimes even four small excretory ducts, leading to small glands, which are precisely of the same nature as those we have mentioned, but which, however, are smaller; they are situated directly under the skin of the areola, and are united with each other and with the body of the gland, by cellular tissue. Sometimes, in fact, but rarely, these small glands open into the portion of the integuments of the mammæ, which directly covers the circumference of the areola. They vary in number and size. There are generally from five to ten tubercles.

Thus the small glands and the tubercles in which their excretory ducts terminate, are arranged in regard to the mammary gland, precisely in the same manner as the sublingual glands or the buccal and the labial glands, are in regard to the parotid and the submaxillary, and they cannot, at least in our opinion, be regarded as anomalies, as Hildebrandt thinks them.*

§ 2486. The mammary gland is situated in a more or less abundant adipose tissue, which does not form a continuous layer as in every other part, for it enters between the depressions which we have mentioned above, and even contrary to what occurs in the other glands, it penetrates deeply into the substance of the organ, while there is none at its base. We find no fat in the nipple nor behind the areola; this fat is more firm and yellowish than in most of the other regions of the body. The mucous tissue which contains it, also penetrates into all the spaces between the different glands. It condenses on the surface of the organ in a special sheath, nearly similar to those which surround the muscles.

Haller asserts† that he has frequently seen milk-passages arise from the fat, which afterwards penetrated into it. Covolo and ourselves have seen nothing like this. We have every reason to think that Haller is mistaken, and that his error must be attributed to the existence of the prolongations mentioned above.

§ 2487. The vessels of the mammæ arise from the external thoracic vessels. Their nerves come from the third and fourth cervical, and from the five or six superior dorsal nerves.

IV. FUNCTIONS.

§ 2488. The function of the mammary gland is to secrete the milk. In the normal state this secretion does not begin until toward the end of gestation. Its history will be more in place after that of the phenomena produced by coition.

ARTICLE SECOND.

PERIODICAL DIFFERENCES IN THE ORGANS OF GENERATION.

§ 2489. Until the sixteenth week there is no trace of the genital organs. When they appear they are formed precisely after the same type in all fœtuses; their form, volume, and situation are the same, and there is consequently no distinction of sex. The internal genital organs are formed:

* *Lehrbuch der Anatomie des Menschen*, vol. iii. p. 339.
† *El. phys.*, vol. vii., p. 8.

1st. Of two very elongated and narrow parts, oblique from without inward and from above downward, situated very high out of the pelvis, and which afterward become either the testicles or ovaries.

2nd. Of two canals which are not much narrower, but which are longer and thicker, proceed beyond them above, and descend on their outer side. They produce either the tubes, or the epidydimi and the excretory organs of the semen, and unite out of the pelvis in a common median duct, which becomes either the uterus and vagina, or the prostate gland, seminal vesicle, and posterior part of the urethra.

3rd. Of a considerable triangular body, a little enlarged at its anterior extremity, situated first at the lower part of the anterior wall of the abdomen, and which afterward hangs loosely forward. This body is formed of two halves, separated by a fissure which proceeds along its lower face; it afterward forms the penis or clitoris.

4th. There is soon developed on each side of this last body a fold of skin, which is directed from before backward. These two folds are not united posteriorly. They change into the scrotum, or the external labia.

§ 2490. Home,* Autenrieth,† and Ackermann,‡ had already admitted this primitive identity of the genital organs in all individuals, although they indicated perhaps less exactly and precisely the characters of the primitive form, and the manner in which the differences occur.

As all the fœtuses at this period, which we have compared and they are at least fifteen, present exactly the formation described, it is more correct to consider, as is generally done, the raphe of the scrotum and penis as a mark of the separation primitively existing, and which gradually disappears by the closing of the fissure from behind forward, than to regard it, with Autenrieth, as proving a tendency to this separation which really occurs only in the female. Thus we have already said for a long time, reasoning from the facts observed by us, that the genital organs are formed after the same type, particularly after that of the female.§

We have already established from observation that their character is still more similar to that of the female in all fœtuses,‖ and Tiedemann has confirmed this result, describing very exactly several fœtuses very near the moment of their formation.¶

* *Phil. trans.*, 1790.

† *Infantis androgyni historia*, Jena, 1805, p. 53.

‡ *Ueber die Verschiedenheit beider Geschlechter*; in Reil, *Archiv. für die Physiologie*, vol. vii., p. 88.

§ *Abhandlungen aus der menschlichen und vergleichenden Anatomie*, 1806, vol. ii. We have there described six fœtuses of this age.—*Beytruge zur vergleichenden Anatomie*, 1808, vol. i., part i., no. 5. We have there described twelve fœtuses of this age.

‖ *Beyträge zur vergleichenden Anatomie*, vol. ii., pt. ii., 170, Leips 1812.

¶ *Anatomie der kopflosen Missgeburten*, 1813, p. 80.

These phenomena are curious in two respects:

1st. There are generally no genital organs in most of the lower animals, or at least those which exist correspond to the genital organs of the female in those where there are two sexes, so that in this respect also the same law prevails in the development of the fœtus and that of the animal series.

2nd. This explains also the greater frequency of female monstrosities.

Farther the great size of the clitoris, the smallness of the uterus, and perhaps also a real connexion between the ovaries and the Fallopian tubes: and secondly, the situation of the testicles in the abdomen, establish still longer between the two sexes a similarity which afterward does not exist.

From the third month of pregnancy, however, the ovaries are always smaller than the testicles; they are situated more horizontally, and the penis differs from the clitoris, as the fissure has disappeared from its surface.

I. GENITAL ORGANS OF THE FEMALE.

§ 2491. The development of the genital organs of the female differs particularly from that of the genital organs of the male, in the less number of successive periods through which it passes.

1. OVARIES.

§ 2492. At first the ovaries,* proportionally speaking, and particularly in regard to the other genital organs, are much larger than they are subsequently. They form for a long time most of these organs, although when the difference of sex is more evident, they are proportionally smaller than the testicles, and this difference even is one of their principal distinctive characters.

At about the middle of the third month of fœtal existence, and when the embryo is two inches long, they are hardly a line and one quarter in length, less than half a line high, and a little less than one third of a line thick. In the full-grown fœtus they weigh between five and ten grains. They are situated almost horizontally far above the small pelvis, but from their horizontal direction their upper or external extremities do not rise as high as the testicles in the male fœtuses of the same age, so that they are very far from touching the kidneys.

Their internal extremities, on the contrary, are so near each other that only the rectum exists between them, which is at this time very narrow, so that the intestine does not completely separate them. Their

* Rosenmuller, *De ovariis embryonen et fœtuum*, Liepsic, 1802.

form is very elongated, narrow, and prismatic; they become rounded only at puberty, and they are then thicker in proportion to their length. Their capsule is very thin, not only in the full-grown fœtus, but also during all the early years of life.

Their tissue is more simple until the middle of the first year of existence. In this respect we have as yet been unable to discover any trace of the vesicles of Graaf before the age of six months, when these vesicles form, and they are then proportionally very large.

In the latter half of the existence of the female the ovaries begin to grow harder and to waste. They loose their smoothness and their surface appears more or less uneven, because the depressions observed in it are changed into considerable cavities.

This effect depends principally on the disappearance of the parenchyma; but the vesicles also change at the same time; they diminish, their membranes become thicker, and finally their cavity disappears, and they are converted into yellowish or blackish, or often into fibro-cartilaginous or osseous bodies.

The ovaries waste so much in females advanced in life that they sometimes disappear entirely, and the place they occupy is indicated only by the vessels. Frequently then they weigh only twenty grains.

§ 2493. According to several writers, as, for instance, Malphigi,* Vallisneri,† Santorini,‡ Bertrandi,§ Brugnone,|| and Buffon,¶ the formation of the *yellow bodies* (*corpora lutea*) belongs also to the history of the development of the ovaries, because they have been found not only in virgins, but in the young females of animals. But it is not well proved that these bodies have the same origin and the same use as the common yellow bodies; and it is extremely probable that their formation has been preceded by an increase in the activity of the genital organs, arising from some cause. We think it more proper to refer the examination of them to the chapter on the changes produced in the genital parts by conception.

II. TUBES, UTERUS, AND VAGINA.

§ 2494. The Fallopian tubes, the uterus, and the vagina, form at first only a single canal, cleft at its upper part, which is uniformly broad, and which extends uninterruptedly from the abdominal extremity of the tubes to the external orifice of the vagina.

* *Diss. ep. var. largum*; in the *Opp. omn.*, Leyden, 1687, vol. ii., p. 223.
† *Von der Erzeugung des Menschen und der Thiere*, pt. ii. c. iii., p. 262, 319.
‡ *Obs. anat.*, c. xi., p. 223.
§ *De glandulæ ovarii corporibus*; in the *Misc. Taur.*, vol. i., p. 104.
|| *De ovarii eorumque corporibus luteis*; in the *Mém. de Turin*, 1790, p. 393.
¶ *Hist. nat.*, vol. ii., p. 203.

A. TUBES.

§ 2495. The tubes are at first proportionally much thicker and longer than they are subsequently.

They descend at first very obliquely from without inward on the outside of the ovaries, to which they are directly united, but extend much beyond their upper extremity. Until the third month they are united at an acute angle at their lower and inner extremities in a small and median perpendicular mass, which is at first very narrow, but which gradually becomes a little wider, and represents the uterus. They are not tortuous until the fourth month.* At five months only they begin to exhibit curves, which are at first very indistinct, and gradually enlarge, so that at eight months and at birth they are more tortuous than in the adult: an arrangement which they preserve also during the first years of life. They seem at first to terminate in a cul-de-sac and by an enlargement.

Their abdominal extremity seems to open at the fourth month, but the fimbriated ends are not developed till afterward. Their cavity is always much larger proportionally the younger the fœtus is, and it is always found without difficulty, whenever it is sought for.†

Between the tubes and the ovaries in the fold of the peritoneum extremely curious vessels‡ exist, not only in the embryo and the fœtus, but also during the first years of life; these cannot be injected through the tubes nor through the ovary, so that we cannot consider them as establishing a communication between the cavity of the former and the substance of the latter; they are so similar in their number, situation, and form, to the vasa deferentia of man, that we must consider them at least as tending to the formation of these passages and the epidydimis.

The primitive form of the abdominal extremity of the tube, however, allows us to conjecture, and with some probability, that they communicate first with the ovary, but that the communication is probably closed when the abdominal extremity of the tube opens, and consequently when a new passage forms.

B. UTERUS.

§ 2496. The uterus is at first, and even usually until the end of the third month at least, much broader, and has two horns. The horns are as much longer and their angle of union is more acute the younger the fœtus is. But when this angle entirely disappears, the

* The general opinion then that the tubes are always tortuous in the fœtus is not exactly correct. Their primitive straightness is very important, on account of the analogy it establishes, first between them and the intestinal canal during the early periods of existence, and also between them and the oviducts of several animals.

† Hirschel and Roesslein have asserted the contrary, but they are wrong.

‡ Rosenmuller, *loc. cit.*

uterus seems to have two horns. At first it is equally broad in every part, and perfectly smooth; there is no prominence either on the outside or on the inside which separates it from the vagina. It begins to enlarge at its upper extremity about the end of the fourth month. This phenomenon depends on the disappearance of the horns which existed at first, and which are replaced by a single cavity. But this upper part is much smaller the younger the fœtus is, whence the neck is larger than the body in the same proportion.

The body gradually increases, so that about the period of puberty the uterus loses its almost cylindrical form, and becomes pyriform. The length of the body is only one fourth of that of the whole organ in the full-grown fœtus; it is only one third at thirteen years old, and does not form one half till after puberty.

At the same time transverse and slightly oblique wrinkles are developed on the anterior and the posterior faces; these converge upwards towards the orifices of the tubes, but are very compact at the lower part where they begin to appear, and gradually extend over the whole of the uterus.

There forms also imperceptibly on the two faces of the organ an elongated eminence which passes through its whole length, and toward which the wrinkles on each side converge from above downward. These wrinkles enlarge very much. They render all the inner face of the uterus very uneven, not only in the full-grown fœtus, but also during the early period of life. They however gradually disappear in the body, and at the age of five years its inner face is entirely smooth.

The external orifice of the uterus appears at first as a slightly perceptible prominence of the organ in the vagina; but this prominence gradually increases, so that in the latter periods of fœtal existence, the vaginal portion of the uterus is proportionally much larger than subsequently. At seven and eight months less than in the full-grown fœtus, and during the first months after birth, all this portion of the organ is very uneven, and also on its external face, presents longitudinal wrinkles, terminated by sharp uneven edges, which are deeply fissured, the grooves of which often occupy all the vaginal portion. This prominence afterwards shortens, becomes smooth externally, takes the form of a glove, and the uterine orifice then appears as a simple and smooth transverse fissure.

The parietes of the uterus are as much thinner in proportion to the cavity, the younger the fœtus is. At first they are equally thick in every part; but at five months they become much thicker in the neck than at the upper part. Gradually between the age of five and six years, the thickness again becomes uniform in every part, and preserves its character till puberty, at which time the body is much thicker than the neck.

Thus the uterus does not assume till very late, its form and the normal thickness of its parietes; but it acquires its permanent length

much sooner, at least in great part. It is even proportionally longer at first, for instance in the full-grown fœtus, than subsequently.

It is the body principally which grows in the adult, and the uterus then assumes a triangular form. In females advanced in age, it becomes irregularly rounded, which does not depend on previous pregnancies, since the same changes are observed in old unmarried females. At the same time it diminishes in those females who have lived in celibacy.

The consistence and the colour of the uterus in old age, resemble those of infancy. At these two periods the organ is hard and white, while in the prime of life it is soft and red.

In the fœtus of three or four months, the uterus is situated almost entirely out of the small pelvis, and it extends much beyond in the full-grown fœtus. After the age of fifteen years, it is entirely situated in the pelvis, at the base of which it is found in old females.

In the fœtus it is almost perpendicular, but its direction gradually changes, so that its greatest diameter is directed almost exactly from before backward.

§ 2497. The functions of the uterus as well as its form, present considerable periodical differences.

At the period of puberty, when the female has the power of conception, there is every month a discharge of blood and serum from the genital organs, which continues some days, and is termed *menstruation* (*menstruatio*, s. *menses*), from its occurring periodically. This discharge disappears with the susceptibility for conception, usually between the fortieth and fiftieth year. It is not a character belonging exclusively to women.* This discharge proceeds from the whole inner face of the uterus.

The discharge usually continues some days, at most a week.

The quantity of blood may be estimated between six and eight ounces.

Its colour is dark, from which character alone it is very probably venous,† which is not the general opinion.

This conjecture is strengthened by chemical analysis. In fact, Lavagna‡ has found in it no fibrin. But Saissy and Mayer§ have proved that the venous blood contains less fibrin, and consequently less azote than the arterial blood.

The uterus enlarges a little during menstruation; its vessels dilate and project like villosities on its inner surface.‖

Menstruation essentially consists undoubtedly in an increase of the vitality of the genital organs of the female, resembling inflammation, and of which hemorrhage is the crisis. This is demonstrated by the

* Cuvier, *Annales du Muséum*, vol. ix. p. 118-130.—Kahleis, *Remarques sur la menstruation*; in the *Journ. compl. des sc. méd.*, vol. xviii. p. 252.

† J. F. Osiander, *Diss. de fluxu menstruo atque uteri prolapsu*, Gottingen, 1808, cap. iii.

‡ In Brugnatelli, *Giornale di fisica*, 1817, p. 397-416.

§ *Deutsches Archiv. für die Physiologie*, vol. iii. p. 534.

‖ Osiander, cap. i-ii.

irritation in these organs before the period of menstruation, the greater propensity of the female at that time for coition, and the greater facility with which she conceives.

We may also consider it as an attempt to form a new organism. In fact, the changes in the uterus at this period, resemble those observed in it after conception. On the other hand, according to the observations of Denman, Brandis, and Joerg, the menstrual blood is not unfrequently attended with membranous productions, similar to the deciduous membrane which is developed when the female has conceived.

Finally, menstruation may carry off from the body generally, and the genital organs particularly, probably not injurious substances, but at least superfluous blood, for while the female is disposed to conceive, the blood always collects in these organs from one menstruating period to another, to form there a new organism, and during pregnancy and lactation it is employed in other formations.

C. VAGINA.

§ 2498. At first the vagina is not broader than the uterus, and is entirely smooth like it. It begins to be uneven at about the same time. First, at about the fifth month a longitudinal elevation appears on each anterior and posterior face. This elevation afterwards presents very many large transverse folds arranged very compactly. These folds are united by others, which are oblique, and are distributed on the whole circumference of the vagina, so as to render its surface much more uneven and reticulated, as they themselves present numerous fissures and folds. This is the appearance of the vagina at seven and eight months. But the folds gradually diminish; they are less evident in the full-grown fœtus; they afterwards gradually disappear, become less prominent, more closely united, farther from each other, so that at the period of puberty, even before coition, the vagina is much smoother, and is only corrugated at its lower extremity on its anterior and posterior faces, in the first more than in the second.

At first the vagina is always proportionally narrower than it is subsequently. It is undoubtedly broadest in proportion, about the seventh and eight month.

It is always proportionally longer in the fœtus than subsequently. It is always more than two inches long in the fœtus of eight months, and in the child at birth, while in the adult female its length is seldom more than four inches. This arrangement depends at least in part on the higher situation of the uterus, but not entirely on this, as the vagina is not narrower in the same proportion.

D. HYMEN.

§ 2499. The vagina is much narrower at its lower part than in other places. We discover no trace of the hymen before the middle of gestation. At this time it begins to appear on each side in the

form of a thin and narrow prominence, which is directed from behind forward, so that a longitudinal fissure exists in the centre. This prominence is at first directed downward, and is equally broad in every part; but it gradually becomes broader backward, so as to form a semicircular fold, or rather a rounded and oblong septum, which presents an opening at its anterior extremity. The hymen preserves this form until it is destroyed. The inequalities of the vagina are also continuous in the fœtus, on it, and on the orifice of the urethra, from whence they descend on the clitoris, and the inner face of the internal labia.

III. CLITORIS.

§ 2500. When the sexual organs are once developed, the clitoris is proportionally very large, and the more so the younger the fœtus is. At the commencement of the third month, when the latter is at most but two inches long, its length is about one line, and it is half a line thick. In fact, it soon loses these large proportions, but it remains considerable during the whole of gestation, so that a slight examination might easily deceive in regard to the sex of the child, which is more probable, because the scrotum is then very small, and the testicles are situated in the abdomen; but the clitoris is always turned forward and downward, and never looks toward the umbilicus.*

This organ presents a deep fissure on the whole of its lower face. At three months we distinguish a longitudinal eminence on the centre of this lower face.

The glans is not entirely exposed until the fourth month; it forms a rounded prominence, and is distinctly separated from the rest of the clitoris. When this period has elapsed, the prepuce grows rapidly, and entirely envelops it. The posterior part of the clitoris is composed of the internal labia and the prepuce; the internal labia are then very much developed during the early periods;† we cannot distinguish them from the prepuce, with which they are directly continuous. As the prepuce forms and extends on the glans, a line of demarkation gradually forms between it and the internal labia, the edge of which was at first straight, becomes rounded; at the same time they evidently divide at their anterior part, and on each side, into two branches, the one small and internal, which goes to the glans, the other external, going to the prepuce. Previously there was no trace of these two branches.

Thus the clitoris and the labia form originally but one mass.

* Walter, *Physiologie*, vol. ii. p. 323.

† According to Osiander, (*Abhandlungen über die Scheidenklappe*; in the *Denkwürdigkeiten für die Heilkunde*, vol. ii. p. 46), the nymphæ are very imperfect, and hardly perceptible at three and four months; observation disproves this assertion. The fact is, that the internal labia are not so large in proportion to the very large clitoris, as they are afterward, but they are very large in respect to the genital organs and the whole body, so that they cannot be mistaken for what they really are not.

IV. EXTERNAL LABIA.

§ 2501. The external labia are at first, at three months, small, rounded, semicircular sacs, convex outward, much thicker anteriorly than posteriorly, and nearer each other at their anterior than at their posterior extremities, and separated forward by the large clitoris, which projects much beyond them. They gradually enlarge, approach each other, as the clitoris does not increase in the same proportion, become more elevated and thinner, and thus their edge becomes sharper. They never, however, cover the clitoris and the nymphæ entirely, during the early periods of existence; first, because these parts are always considerably large; second, because they themselves are but slightly developed.

II. GENITAL ORGANS IN THE MALE.

§ 2502. The genital organs in the male during their development, pass through several periods, which are very important in a physiological, pathological, and surgical point of view. The differences they present, relate to their situation, form, and size.

I. TESTICLES.

§ 2503. The testicles* deserve to be first considered, as they are the most important parts, and appear first.

They form not in the scrotum, but in the abdomen, and particularly in the peritoneal cavity, and has the same relation to it as have all the other organs enveloped by this membrane.

About the middle of the third month their upper extremity still touches the lower extremities of the kidneys. At this time they are situated obliquely from above downward, and from without inward,

* Haller, *De herniis congenitis, programma ad dissertationem Steding*, Gottingen, 1749.—Pott, *On ruptures*, 1756, p. 13.—Camper, in *Verhandelingen van het Harlemsche genootschap*, 1761, vol. vi. part i.—J. Hunter and G. Hunter, *Medical commentaries*, London, 1762, p. 1. p. 75.—Id., in *Observations on certain parts of the animal economy*, vol. i.—Arnaud, in *Mémoires de chirurgie*, vol. i. no. i. London, 1768.—Lobstein, *De herniâ congenitâ, in qua intestinum in contactu testis est*, Strasburg, 1771.—J. F. Meckel, *De morbo hernioso congenito singulari*, Berlin, 1772.—Girardi, in Santorini, *Septem. tab.*, Parma, 1775, p. 184-202.—J. B. Palletta, *Nova gubernaculi testis Hunteriani et tunicæ vaginalis anatomica descriptio*, Milan, 1777.—H. A. Wrisberg, *Observationes anatomicæ de testiculorum ex abdomine in scrotum descensu*, Gottingen, 1779.—Vicq-d'Azyr, in *Mém. de Paris*, 1780, p. 494-507.—J. Brugnone, *De testium in fœtu positu, de eorum in scrotum descensu, de tunicarum quibus hic continentur, numero et origine*, Turin, 1785.—Tumiati, *loc. cit.*, p. 541.—J. F. Lobstein, *Recherches et observations anatomico-physiologiques sur la position des testicules dans le bas-ventre du fœtus et leur descente dans le scrotum*; in Schweighæuser, *Archives de l'art des accouchemens*, Strasburg, 1801, vol. i. p. 269.—B. G. Seiler, *Observationes nonnullæ de testiculorum ex abdomine in scrotum descensu et partium genitalium anomaliis*, Leipsic, 1817.

fill the space between the kidney and the bladder, and consequently occupy all the inner face of the ossa ilia.

They are very large, since in the fœtus of this age, which is scarcely more than two inches long, they are two lines in length and one line thick. They are rounded and oblong, convex anteriorly and concave posteriorly, and rest on a very broad fold of the peritoneum, which first covers the epidydimis, then goes on the posterior and concave face of the testicle, leaving between them a great space, arises from the posterior face of this gland, but is by no means as high as that, and is very similar to the epiploon. They adhere to this fold so slightly, that their situation is easily changed, and particularly carried outward or inward. The epidydimis rises no higher than the testicle, descends at its side from before backward, and a little from within outward, and is continuous at its lower extremity with the vas deferens, which descends into the small pelvis behind the peritoneum. At the place where this continuation occurs, the whole mass, but the epidydimis and vas deferens particularly, rest directly on a short, very fine, rounded cord, which arises from a depression of the lower wall of the peritoneum, at about the centre of the crural arch, which is also covered by the peritoneal membrane, but less loosely than the testicle, because the fold is shorter in the point which corresponds to it. This cord is infinitely thinner than the testicle and the epidydimis.

It is the *sheath* (*vagina*) of Haller, the *gubernaculum* of Hunter, the *cylinder* of Camper, the *basis* of Gerardi.

After this period the proportionally large size of the testicles rapidly diminishes.

At four months, when the fœtus is four inches long from the vertex to the coccyx, their length is scarcely two lines and a half, and their thickness at most but one line. The epidydimis is then larger in proportion to the testicle, than before or afterward. The testicles are situated a little lower, but very little however, but are more remote from the kidneys, being at least four lines from them, because the ossa ilia are much larger. The vas deferens is then reflected a little from below upward on leaving the lower extremity of the epidydimis, so that it describes an arch before descending into the pelvis. The gubernaculum is much larger, and it arises from the region of the inguinal ring, although the peritoneum is not perforated in this place; but is only reflected on itself from below upward, and envelops a mucous mass to which we must attribute the thickness and the more round form of the gubernaculum.

At five months, the testicles are not longer than in the preceding month, but they are about half a line thicker, so that they appear a little rounder than they were then. They have not descended lower, or at least but very little, and they are still more than a line distant from the lower wall of the peritoneum. The gubernaculum, which is then evidently triangular and the summit of which is much thinner than the inguinal ring and goes downward, while its base looks upward, ascends obliquely from within outward. It begins a little below

the inguinal ring, at the upper part of the scrotum, by some distinct fibres, passes through the ring, then receives some fibres from the obliquus internus and transversalis abdominis muscles, behind which it passes, then ascends on the iliacus muscle, and rises directly to the lower extremity of the epidydimis. At its lower part, between the inguinal ring and the place where it appears in the abdominal cavity, we discover before it a prolongation of the peritoneum (*processus peritonei*) which términates in the ring in a cul-de-sac. This prolongation also descends obliquely from without inward. Its upper orifice is much broader than the lower, and than the gubernaculum which passes through it. This last is filled with a soft and gelatinous mass: it however contains no cavity. The epidydimis is evidently tortuous at its lower part, and the vas deferens is slightly so at its origin.

At six months the testicles are still situated in the same place. At this time they are only four lines long, and one and a half thick, so that they are proportionally oblong, and almost straight. The epidydimis rises a little above the surface of the glans, and like the vas deferens, it is more distinctly curved than in the preceding month. The same is true of the gubernaculum and the prolongation of the peritoneum. Sometimes we may pass air into the lower part of the gubernaculum, and it is sufficient in certain cases to cut it across to perceive that it is hollow.

Thus, there has hitherto existed a canal, terminated in a cul-de-sac, a prolongation of the peritoneum, which descends from about the centre of the lower tendon of the obliquus abdominis externus muscle, between this muscle and the lower edge of the two broad internal abdominal muscles, and behind which proceeds a prolongation of mucous tissue, which is generally solid, and to which are added some fleshy fibres from the two broad internal abdominal muscles. But the testicle is still loose in the cavity of the peritoneum, where it rests on the upper extremity of the gubernaculum.

At seven months we generally find it directly on the upper extremity of the canal, or more or less within it, so that frequently it does not project at all beyond it, or only in a very small part of its upper extremity. It is usually situated behind the lower edge of the obliquus abdominis externus muscle. The prolongation of the peritoneum then extends downward, to just above the inguinal ring. It seems composed of two layers, the internal of which is thinner, and is continuous with the peritoneum, while the external is a mucous tissue, and is continuous with the sheath of the obliquus abdominis externus muscle, in which are distributed the fleshy fibres coming from the obliquus internus abdominis and the transversalis muscles. The lower part of the prolongation of the peritoneum is filled above by the lower extremity of the epidydimis, and by the commencement of the vas deferens; these rest on a small mass of mucous substance, which rises from the lower extremity of the prolongation of the peritoneum, and they are united with it posteriorly by a fold, which is detached from the posterior wall of this prolongation.

At eight months, the testicle itself usually passes through the inguinal ring, and gradually, until the end of the ninth month, arrives at the bottom of the sacrum, so that its situation is normal about the period of birth. The prolongation of the peritoneum is then considerably elongated; it is open its whole extent, excepting only its lower extremity, which terminates in a cul-de-sac, and it communicates freely by its upper with the proper peritoneal cavity.

After the testicle has descended entirely to the bottom of the peritoneal prolongation and of the scrotum, its cavity still continues to communicate with that of the peritoneum for a greater or less length of time, but not more than a few weeks when the development is perfectly normal. But the canal of union gradually contracts at its centre, a little nearer the top than the bottom, so that usually that portion of the prolongation of the peritoneum which surrounds the testicle, begins to be obliterated near the inguinal ring. The upper portion of the canal from the inguinal ring to the centre of the crural arch, or to the place where the vas deferens joins the spermatic vessels, remains open a considerable time; but when the child is regularly developed, it is also obliterated during the first months after birth, so that it is finally only indicated by a slight depression, which by no means always exists.

The central portion of the canal of communication also is perfectly obliterated as high as the upper extremity of the testicle, and entirely disappears in most cases. At least we have rarely been able to see any traces of it, although we have made the most careful examinations on this subject. We cannot then agree with Brugnone and Scarpa, that we always find in the adult a special cord, composed of cellular tissue, termed by them the *bridle* (*habenula*), which they consider as the remains of a canal of communication, and the cavity of which they assert can always be demonstrated by maceration.

Thus the canal of union is first obliterated, and then disappears. Adhesion in it results from its serous nature, and like its disappearance, it is perhaps favoured by the pressure of the testicle upon it.

§ 2504. Farther, these changes in the situation of the testicles do not occur at the same period, and uniformly on the two sides; one of the two organs usually comes into the scrotum long before the other.

The anomalies in the progress of this phenomenon are as follow:

1st. The early descent of the testicles. This case is rare: Wrisberg has found the testicles in the scrotum at four and five months, and has also remarked that the canal of communication was then obliterated.*

2nd. A suspension of development, from whence several periods are retarded, or even never supervene. This case is much more common than the preceding. The greatest anomaly is where one testicle

* Loder, *Journal*, vol. i., p. 175.

or both remain in the abdomen or in the inguinal region, from whence we may think one or both of these organs are deficient.

In this case the testicles are arranged in regard to their envelops precisely in the same manner as in the fœtus, as they are entirely exposed, and are provided with a gubernaculum. The least anomaly is where the peritoneal prolongation is imperfectly obliterated. When this last anomaly exists in the greatest degree, the canal remains entirely open, so that the testicle is inclosed in the same cavity as the other abdominal viscera, although its position is otherwise changed. When the anomaly is less, sometimes and most frequently, only the upper part of the peritoneum is open, which extends between the inguinal ring and the obliquus abdominis internus muscle; sometimes and more rarely the lower part of the prolongation does not adhere, so that not only the layer which surrounds the testicle, and which becomes the external layer of its proper vaginal tunic, forms an oblong and rounded cavity, but also we see arise from the upper extremity of this sac a canal varying in length, which marks the old canal of communication; sometimes finally and more unfrequently, the obliteration occurs regularly at the two extremities of the canal of union, but the central part of this latter continues in a greater or less extent.

We shall mention hereafter the diseases produced by these anomalies.

§ 2565. The testicle differs considerably both in respect to situation and its envelops, whether it is found in the abdominal cavity or in that of the scrotum.

While it is situated in the abdomen, it is surrounded only by the albugineous tunic and the portion of the peritoneum which passes on this membrane.

The fold of the peritoneum, which is attached to the latter, is continuous with the posterior wall of the peritoneum, and at this period the testicle, like the other abdominal viscera, is not inclosed in a proper capsule, with which this serous fold is continuous, as are the lungs or the heart.

The other envelops which cover it in the scrotum are developed at the expense of the gubernaculum, and the prolongation of the peritoneum. The peritoneum becomes the external and loose layer of the proper vaginal tunic of the testicle, with which, when the testicle has descended, the internal layer is continuous, precisely in the same manner as it was previously connected with the external wall of the peritoneum.

The common vaginal tunic of the testicle and the spermatic cord is formed from the cellular tissue within the gubernaculum.

At this period also the fibres coming from the two internal muscles of the abdomen, which were at first ascending, go outward, and form the cremaster muscle. The cellular tunic or the dartos already existed in the scrotum, and the testicle entered it on descending.

These changes depend principally on the fact that the gubernaculum gradually turns, so that its internal face becomes external, and

its upper extremity becomes the lower; hence the epidydimis which is attached to it, and with it the testicle, are necessarily drawn from above downward. The prolongation of the peritoneum also emerges in the same manner outward, and independent of this inversion, since it already exists before the testicle descends, and it supervenes also in hernias which are caused simply by the spontaneous prolapsus of the peritoneum, without any other mechanical change.

The descent of the testicle is generally explained entirely in a mechanical manner, and attributed to the compression produced by the motions of respiration upon the abdominal viscera,* or to the weight of the testicle,† or to the greater flow of blood into its vessels,‡ or finally to the contraction and inversion or to the reversion of the gubernaculum.§

The first opinion is not correct, since when the formation is normal the testicles usually descend in the scrotum long before birth, and they are often found in the abdominal cavity long after parturition, when the formation is abnormal. The second is refuted by the habitual situation of the fœtus, as the testicle would ascend against its specific gravity. The third is inadmissible, because if true the testicles should be situated as much lower the younger the fœtus is, since then they are proportionally the largest.

The contraction of the gubernaculum doubtless does not cause the gliding of the testicle to the inguinal ring; but it does not contribute to its farther progress in the scrotum, for instead of favouring its motion in this direction it would rather contribute to raise it. We cannot, however, deny that it assists very much to the displacement of the organ, and this is proved positively by the great development of the muscular fibres of the gubernaculum in those animals where the testicles possess alternate motions, whence they enter and leave the cavity of the abdomen alternately.

If sometimes the testicles do not descend, although the gubernaculum exists, we must not conclude that this latter takes no part in the phenomenon, since other circumstances may prevent its action, or at least may produce the effects it generally causes. Farther, its contraction is only one mode of causing the displacement of the testicle, and the cause of this displacement is unknown to us.

§ 2506. When man has passed the period of his virility, the testicles diminish a little, at least frequently; but they rarely waste as much as the ovaries, and the power of impregnation continues longer in the male than that of conception in the female.

The scrotum gradually relaxes more or less, so that the testicles descend lower.

* Haller.
† Haller, Pott.
‡ Haller, Tumiati.
§ Paletta, Vicq-d'Azyr, Brugnone.

§ 2507. The secretion of semen commences about the same time that menstruation does, but it usually continues a little longer.

II. PENIS.

§ 2508. About the middle of the third month the glans is not yet covered by the prepuce, and a deep groove separates it posteriorly from the proper penis, which is larger than it.

Its anterior extremity is imperforate; we only perceive a whitish spot at the place where the urethra afterwards opens. But we always observe at this period a longitudinal fissure, which sometimes exists posteriorly on the small portion of the lower face of the glans, and which constantly occupies the anterior extremity of the lower face of the penis situated directly next to it.

Thus the urethra does not extend as far forward as when the development is completed, and farther its anterior part presents a fissure below. This fissure, however, by no means extends to the posterior extremity of the penis.

The scrotum is very small, is separated very distinctly from the penis forward, and is entirely closed.

At four months, the appearance of the scrotum is not changed, but the form of the penis is altered. The glans is a little larger proportionally, is covered by the prepuce at its posterior and inferior part, so that only the lower part of its anterior side is exposed, and we remark at the lower part of its anterior surface a longitudinal fissure, which is the opening of the urethra.

Next comes a state directly opposite, which continues during the whole of gestation. The prepuce is very much enlarged, covers the whole glans, and presents only a very narrow opening; it is adapted so intimately to the surface of this part that it cannot be drawn backward.

Thus in the normal state there is paraphymosis during the early periods of fœtal existence, and phymosis during those that succeed.

III. MAMMÆ.

§ 2509. The mammæ are already apparent at the third month of pregnancy, at which period the nipple is scarcely perceptible, but presents a very broad opening. It is worthy of remark that they generally contain during the latter period of gestation, and in the fœtus at birth, a lactescent liquid, of which there is often a considerable quantity. Until the period of puberty they present no marked differences in the two sexes; but at this time they enlarge more or less in the female.

They are more or less hard and solid. As age advances they di-
ninish, which occurs sooner when their action has been exhausted
y frequent lactations. Even where their mass does not seem dimi-
ished, and they are even enlarged, the substance of the gland is,
owever, replaced by fat.

ARTICLE THIRD.

IFFERENCES IN THE GENITAL ORGANS PRESENTED BY DIFFERENT RACES.

§ 2510. Beside the differences depending on the sexes and the riods of life, the genital organs present others which relate to the ces of the human species.

The most remarkable are those in the external genital organs of e female and the mammæ.

The internal labia are very long in certain Ethiopian races, among ners that of the Boschismans, as we have already mentioned. This the origin of the *apron* of the Hottentots, which the recent obser- tions of Somerville and Cuvier have demonstrated not to be a new gan.

The mammæ are also very much developed and very long in the ottentots, who can throw them over their shoulders.

We have already mentioned the great size of the penis in ne- oes.

ARTICLE FOURTH.

MPARISON OF THE MALE AND FEMALE GENITAL ORGANS.

2511. We have already mentioned several times that the genital ans of the two sexes are formed primitively in the same model, l that they should be considered only as modifications of the same damental type.

n fact it is easy to demonstrate that all the parts which unite to m this system exist equally in both sexes, and differ only in size, ation, and structure. The analogy appears much greater the nger the fœtus is, and that it is founded on the nature of things is ved by the fact that they are originally of the same sex.

The testicles correspond perfectly to the ovaries in form and functions, the vessels and nerves they receive, and even, at first, in situation.

The Fallopian tubes are evidently analogous to the vasa deferentia. We however have reason to think they originally communicate with the ovaries by straight canals, and by a kind of epidydimis similar to that which exists in the male between the vas deferens and the testicle.

The seminal vesicles and the prostrate gland undoubtedly correspond to the uterus in respect to situation and connection, with the vasa deferentia, and the Fallopian tubes; the uterus however is larger and more completely developed, and the orifices of the seminal canals are more remote from each other.

The penis and clitoris are similar in essential respects as to situation and structure. They differ only in their respective size, and because the urethra does not extend under the clitoris. This difference however disappears, when we consider the imperfect development of the clitoris is compensated by that of the vagina or nymphæ, which must consequently be regarded as the penis and urethra of the male, the two lateral halves of which are separated, and which are turned inward instead of outward.

In this respect also the analogy is greater in the early periods, since then the urethra does not extend to the anterior extremity of the penis.

We explain in the same manner the difference between the bulbo-cavernosi and the constrictor vaginæ muscles. These two muscles correspond; the two halves of the second, however, are united only on the median line.

The external labia represent the two halves of the scrotum, which are separated.

The mammæ differ only in size, and this difference is almost nothing before the period of puberty.

Thus the analogy of the genital organs of the female is found in the other sex. The history of hermaphrodites will demonstrate that the deviations of formation contribnte still more to efface the differences between the two series of organs, and these anomalies produce between them so great a resemblance, that it is often very difficult to determine to what sex the individual really belongs.

ARTICLE FIFTH.

GENITAL ORGANS IN THE ABNORMAL STATE.*

I. GENERAL ANOMALIES.

§ 2512. The genital organs present some anomalies common to ne two sexes, and others peculiar to one only, a remark which pplies also to deviations of formation and alterations of texture. In is respect we must remark, that the corresponding sections of the enital organs usually participate in the same anomalies, or at least resent those which are very analogous.

We observe in both sexes:

1st. Suspensions of development and developments continuing fter the type of the fœtus. Such are:

a. The entire or partial absence of the genital organs. The first nomaly causes the total absence of sex, although the rest of the ody sometimes indicates clearly to what sex the individual would ave belonged if the genital organs had been developed.

b. Abnormal smallness.

c. The abnormal continuance of a primitive formation.

These anomalies are not rare.

2nd. Plurality, which is much less common.

3rd. The too early development, although more common than the eceding anomaly, is however a rare phenomenon.

* Consult, 1st. On the diseases of the genital organs generally: Vercelloni, *De dendorum morbis*, Leyden, 1725.—2nd. On those of the organs of the female in ticular: J. G. Walter, *Ueber die Geburtstheile des weiblichen Geschlechts*, Ber-, 1776.—Justi, *Diss. exhibens observationum seriem circa genitalia muliebria*, rburg. 1798.—Thamm, *Diss. de genitalium sexus sequioris varietatibus*, Halle, 9.—3rd. On those of the external genital organs of the female: Louis, *De parm externarum generationi inservientium in mulieribus naturali, vitiosâ et mora dispositione*, Paris, 1764.—4th. On those of the ovaries; Kruger, *Pathologia riorum muliebrium*, Gottingen, 1782.—Motz, *De structura, usu et morbis ovaum*, Giessen, 1789.—5th. On those of the Fallopian tubes: Leonhardi, *Quædam tubarum uterinarum morbis*, Wittemberg, 1808.—6th. On those of the matrix of the vagina: A Vater, *De morbis uteri*, Wittemberg, 1709.—Haller, *De rbis uteri*, Gottingen, 1753.—Schwarz, *De uteri degeneratione*, Jena, 1792.—rke, *Diseases of females*, London, 1814.—7th. On the anomalies of the hymen: Tolberg, *De varietate hymenum*, Halle, 1791.—Osiander, *loc. cit.*—8th. On the ases of the genital organs of the male in general: G. Wadd, *Cases of diseased dder and testicle*, London, 1815.—9th. On those of the testicle: Henrel, *Diss. norbis scroti*, Strasburg, 1723.—J. Warner, *Account of the testicles and the diss to which they are liable*, London, 1774.—10th. On those of the prostate nd: E. Home, *Observations pratiques et pathologiques sur le traitement des adies de la glande prostate*, Paris, 1820.—11th. On those of the penis: Brocksen, *De excretionis urinæ impedimentis a vitiis membri virilis*, Strasburg, 1781. haut, *De virgæ virilis statu sano et morbosa*, Wurzburg, 1808.—C Bell, *Engrav- of specimens of morbid parts*, London, 1813.—J. Howship, *Practical observas on the diseases of the urinary organs*, London, 1816.

4th. It is less rare to find the characters of both sexes blended in the same individual, one or several parts of whom are formed after the type of one sex, and the rest of the body after that of the other sex. This anomaly essentially constitutes hermaphrodism.

5th. Alterations in texture. They are seen most frequently, and are most developed, in the genital organs. Not a single new formation but has been seen in some parts of the genital apparatus, which undoubtedly depends on the energy of the formative power being greater in this than in any other of the organic systems.

II. SPECIAL ANOMALIES.

A. DEVIATIONS IN FORMATION.

I. HERMAPHRODISM.

§ 2513. *Hermaphrodism,** which constitutes the second class of deviations of formation in regard to quality, is indicated in the formation of the genital organs, of which alone we shall treat here, by the formation of one part of the sexual system, after a type contrary to that of the rest or of the whole body, that is, with or without an increase in the organs of generation.

The second case is infinitely more common than the first.

The genital organs of the male assume the characters of the female:

1st. By the continuance of the testicle in the abdomen, and generally by the imperfect disappearance of the primitive relations of locality.

2nd. By the interruption of the vas deferens.

3rd. By the higher situation, the increase in volume, and enlargement of the prostate gland.

4th. By the smallness of the penis.

5th. By the different degrees of its imperforation.

6th. By the division of the scrotum; and the existence between the penis and the anus of a canal similar to the vagina, varying in its dimensions, which leads to the prostate gland, and which is often attended by one of the three preceding anomalies.

7th. By the development of one or of the two mammæ resembling those of the female in respect to size and function.

The genital organs of the female assume the characters of the male:

1st. By the hernia of the ovaries through the inguinal ring.

* J. F. Meckel, *Ueber die Zwitterbildungen*; in Reil, *Archiv. für die Physiologie*, vol. xii.—Burdach, *Die Metamorphose der Geschlechter, oder Entwicklung der Bildungsstufen durch welche beide Geschlechter in eidander ubergehen*; in his *Anatomische Untersuchungen*, part i. 1814.—All the works which have appeared before on the same subject are mentioned there.—Seiler, *Observationes nonnullæ de testiculorum ex abdomine in scrotum descensu et partium genitalium anomalis*, Leipsic, 1787.—J. Feiler, *Ueber angeborne menschliche Missbildungen, im allgemeinen, und Hermaphroditen insbesondere*, Leipsic, 1820.

2nd. Perhaps by the adhesion of the tubes with these glands.
3rd. By the smallness and sloping situation of the uterus.
4th. By the narrowness and shortness of the vagina.
5th. By the enlargement of the clitoris and the extension of the urethra to its surface.
6th. By the adhesion of the large and small labia.
7th. By the imperfect development of the mammæ.

All these anomalies do not necessarily coexist in the same organism: but hermaphrodism, and the equivocal character of the sex which depends on them, are more marked, the greater the number of those existing.

Generally only one or some of the different parts of the genital apparatus are constructed after different types, and the synonymous parts of the two sides correspond. It is much more rare to find an hermaphrodism so perfect that each of the two lateral faces present all the characters of a different sex.

Finally the greatest degree of hermaphrodism consists in the development of some parts constructed after a sexual type contrary to that of all the others.

But few authentic instances of this last and the preceding anomaly are known, and they all differ in respect to quality and quantity.

All these varieties of hermaphrodism present more or less distinct and perfect analogies with animals.

Hitherto, however, not a single instance of human hermaphrodism is known where the two sexes were so completely united that it was possible either alone or with other individuals to procreate both as a male and female.

All imaginary reasonings, however, cannot demonstrate the impossibility of such a formation, as it exists in many animals, as hermaphrodites have been seen which were very nearly in this state, as several phenomena seem even to prove that a perfect male organism sometimes possesses the creative power, independent of the other sex, and we cannot to a certain extent absolutely refuse this power to the female.

II. DEVIATIONS IN FORMATION OF THE SPECIAL GENITAL ORGANS.

A. GENITAL ORGANS.

a. Ovaries and tubes.

§ 2514. Among the primitive deviations of formation in the ovaries and their excretory ducts, the Fallopian tubes, we remark the following, which arise mostly from suspended development :—

1st. The absence of an ovary, or more rarely of the two, with or without simultaneous absence of its tubes.

2nd. Smallness.

3rd. The absence of the vesicles of Graaf in the ovaries of barren women.

4th. The closing of the abdominal extremity of the tubes.

This last state is frequently developed after inflammation; it then constitutes a consecutive deviation of formation.

Another anomaly, which is generally congenital, but more rare, consists in the hernia of the ovaries and Fallopian tubes through the inguinal ring, in which case they resemble the testicles.

b. Uterus.

§ 2515. The primitive deviations in the formation of the uterus, most of which consist in its suspended development,* are:

1st. Its total or partial absence. In the latter case sometimes the upper and sometimes the lower part is deficient.

2nd. Its smallness, with thinness of its parietes.

3rd. The continuance of its form at a primitive degree of development.

Here exist several degrees which essentially consist most frequently in a divison into two halves.†

When the anomaly exists in the greatest degree possible, the uterus is divided at its upper part into two horns, and also divided into two halves by a septum at its lower part. Next come two nearly equal degrees: sometimes the body of the organ is extended into two horns, and the neck is single; sometimes the form of the uterus is normal externally, but its cavity is divided into two halves at its lower part by a septum. Next come two other degrees; in one a groove more or less deep at the bottom of the organ makes it appear imperfectly double horned, in the other, it is single externally, while its body is divided into two portions.

Finally, when the anomaly is as slight as possible, the form of the uterus is only more elongated.

These different degrees in the anomaly present very remarkable resemblances with the formations seen in animals, and with animals situated as much lower in the scale as the deviation is greater.

Primitive deviations of formation consisting in an excess of the formative power, are hardly known. The term *double uterus*‡ has been wrongly applied to those which present several of the anomalies mentioned by us.

The deviations in formation in respect to quality which relate to form and situation, are rarely primitive.

* See our *Handbuch der pathologischen Anatomie*, vol. i.

† Thamm (*loc. cit.*) has given a complete list of works published on this subject.—F. J. Hunkelmœller, *De vaginâ et utero duplici*, Berlin, 1818,

‡ F. Tiedemann, *Observation d'une grossesse chez une femme dont la matrice était double*; in the *Journ. compl. des sc. méd.*, vol. vi, p. 371.—Mad. Boivin, *Mémorial de l'art des accouchemens*, p. 85.

The uterus however is sometimes oblique, which state is generally ·ended with its obliquity in respect to situation.*

The accidental deviations of formation are:—

1st. *Abnormal situation.* The principal varieties of this anomaly ·e the following:

a. The *situation of the uterus out of the median line,* in which case generally rests against one of the sides of the pelvis.

b. Obliquity, in which its direction is from one side to the other. ·his state, especially when the uterus is unimpregnated, generally ·sults from adhesions with the adjacent parts.

c. Retroversion,† in which the longitudinal diameter of the uterus ·rresponds to the antero-posterior diameter of the pelvis, so that its ·se is directed downward and backward, and its vaginal orifice up·rd and forward. This anomaly occurs particularly during the ·urth month of pregnancy.

d. Prolapsus,‡ where the uterus, most frequently from an inver·n of the vagina, descends more or less into the pelvis. When the ·gina is entirely inverted the uterus is depressed its whole extent, ·l the lower orifice is situated at the lower extremity of the tumor ·med by it between the thighs. Usually also the neck is more or ·s elongated, and the uterus adheres to the primitively external ·e of the inverted vagina.

From the elongation of the neck, however, the body of this latter ·arely situated on the outside of the sac of the vagina. In this de·tion of formation the orifice of the uterus is rarely completely ·iced.§

Sometimes the uterus, even when it contains a fœtus, forms a hernia.

2nd. *Abnormal form.* One accidental anomaly in the formation of · uterus connects it with the proper deviations of formation, as it ·attended with displacement of the organ.

This is *inversion,*|| which consists essentially in the turning out·d of the inner face of the uterus. It appears in several degrees, ·sometimes only the base of the uterus approaches the orifice, and ·etimes it projects through this opening. The tumour it forms in · latter case differs from prolapsus, as its lower part presents no ·ning. This fact happens only when the cavity of the uterus is ·siderably distended and its walls are proportionally thin, and the ·an is then compressed or drawn down by the base. Thus it is ·erved in parturition, in uterine polypi, &c.

* Boer, *Abhandlungen geburtschülflichen Inhalts,* vol. i. p. 1.

† Cuyper, *De retroversione uteri,* Leyden, 1772.—Korscheck, *De retroverso ·o,* Halle, 1799.—One is figured in Hunter, *De utero gravido,* tab. xxvi.

‡ Bœhmer, *De prolapsu et inversione uteri,* Halle, 1745.—It is figured in ·sch, *Obs. med. chir.,* obs. 2 and 8.—Baillie, *Engr. fasc.* ix. fig. i.—Clarke, ·*ases of females,* London, 1814, tab. i-v.

§ Beclard and Cloquet, in the *Bull. de la fac. de méd.,* vol. v. 1816, p. 114.

|| Van Sanden, *De prolapsu uteri,* Leipsic, 1723.—Saxtorph, *Auszüge aus der ·andlungen der Copenh. Gellesschaft,* Halle, 1785.—It is figured in Ruysch, ·*anat. chir. cent.,* obs. x.—Denman, *Introduction to the practice of mid·ry,* tab. xii-xiv.—Baillie, *Engravings,* fasc. ix., fig. 2.

Rupture is a deviation of formation of the uterus occurring under similar circumstances, although it is rare, except in a state of pregnancy; it occurs when parturition is opposed by any cause, and is seen, particularly at the lower part of the organ, in a transverse direction.

The *obliteration* of the cavity of the uterus is generally partial, and commonly occupies the lower part of the organ, to a greater or less extent.

It is sometimes congenital, and may then constitute a primitive anomaly; but it frequently supervenes after suppuration and ulceration.

c. Vagina.

§ 2516. Sometimes the vagina is imperforate, or is even deficient, and a loose cellular tissue exists in its place. This anomaly is most generally primitive. Its least degree is the closing of the canal, or the very great thinness and hardness of the hymen.

Sometimes the vagina is divided in a greater or less extent into two halves by a longitudinal septum, directed from before backward, so that when the division extends to its lower extremity even two hymens exist. This anomaly may or may not be attended with an analogous state of the uterus.

The vagina also presents primitive deviations of formation in respect to length and breadth. In fact it is sometimes extremely narrow and very short, which anomalies exist alone or together.

The most common consecutive deviation of formation is the imperfect* or perfect retroversion of the vagina, attending the prolapsus of the uterus. The bladder is then generally drawn downward, and very frequently also we find calculi, which may sometimes produce the disease, and sometimes have been produced by it.†

The vagina is sometimes ruptured in the same cases as the uterus, but more rarely than it.

d. External labia.

§ 2517. The external labia are sometimes deficient, from a primitive deviation of formation, or adhere to each other on the median line. These two anomalies result from the permanence of a primitive state of formation.

They rarely contain the abdominal viscera which have escaped through the inguinal ring.

* Naudin, *Mémoire sur les chutes partielles du vagin*; in the *Journ gén. de méd.*, vol. lvi. 1816, p. 259.

* Ruysch, *Obs. med. chir.*, obs. i.—Paget (*Lond. med. and phys. Journ.*, vol. vi. p. 391) mentions a stone weighing twenty-seven ounces, attended with several smaller ones, found in a case of prolapsus of the bladder.

Sometimes they enlarge very much, either suddenly, from the metastasis of other diseases, particularly blennorrhea, or slowly and gradually.

e. Internal labia.

§ 2518. Sometimes also the nymphæ are deficient, or adhere. These two states may be primitive or accidental, and developed after an inflammation. In some cases they present an opposite anomaly, and are double or even triple.* Their unusual enlargement is commonly consecutive or accidental.

f. Clitoris.

§ 2519. The clitoris is sometimes unusually large, and then resembles the penis in the male, particularly when the urethra extends unusually far forward. Sometimes this part is enlarged in consequence of syphilitic affections, and its texture is altered; it then becomes harder, firmer, and irregular.

Its *fissure* is an anomaly interesting as analogous with animals.

B. GENITAL ORGANS IN THE MALE.

a. Testicles.

§ 2520. The deviations in the formation of the testicles are:—

1st. That *absence* of one of these two organs, which must be distinguished from its apparent absence, depending on the gland contituing in the abdomen.

2nd. *Smallness.*

3rd. Permanence in their primitive situations. This anomaly presents a great many degrees, from the case where the testicle remains below the kidney to that where the canal of communication, which continues some time after leaving the abdomen, is imperfectly obliterated. This last deviation of formation becomes the cause of congenital inguinal hernia.

4th. The interruption of the vas deferens, its termination in a cul-de-sac, the absence of the seminal vesicles.†

5th. The plurality of the testicles. This anomaly is very doubtful. The seminal vesicles also are rarely more than two in number.‡

The consecutive deviations of formation are:—

1st. Abnormal enlargement.

2nd. Atrophy.

* Neubauer, *De triplici nympharum ordine*, Jena, 1774.

† See our *Handbuch der pathologischen Anatomie*, vol. i., p. 685.—A. Bosch, *Diss. sistens observationem de vesiculæ seminalis sinistræ defectu, integris testibus, vase vero deferente sinistro clauso*, Leyden, 1813.—Seiler has published an excellent account of the post-mortem examination of a person affected with cryptorchis.

‡ Meckel, *De duplicitate monstrosa*, in *Handbuch der pathologischen Anatomie*, vol. ii. p. 32.

These two states are most frequently attended with alterations of texture.

b. Prostate gland.

§ 2521. The prostate gland is particularly subject to enlargement, which is sometimes attended with a change in its tissue. In this case it is usually said to have become schirrous; this assertion is true sometimes, but not always. Hypertrophy of the prostate gland often depends on the development in its substance of fibrous or fibro-cartilaginous formations, which are also as common in its corresponding organ, the uterus.*

The middle lobe of the prostate gland is often swelled abnormally; but this swelling does not always exist, which is contrary to Home's assertion.

c. Penis.

§ 2522. The penis presents a great number of primitive deviations of formation, which depend principally on a suspension of development, or the permanence of a primitive form. They are:—

1st. Absence.

2nd. Smallness.

3rd. Total or partial imperforation, which presents several differences, either in respect to the degree or the quality, from the closing of the prepuce to the opening of the urethra in the perineum, which is or is not attended with the abnormal smallness of the penis; in this case the lower part of the urethra, and consequently of the penis, are in fact cleft on their lower face.†

4th. The narrowness of the prepuce, or *phymosis,* which is generally accidental.

5th. The fissure of the penis at its upper face, which is often attended with that of the bladder, and which when existing alone makes the transition from this latter anomaly to the normal formation.

6th. The complete division of the penis into two halves. This deviation of formation is much more rare than the preceding.‡

On the other hand, sometimes the penis is more or less perfectly double.

Perhaps we ought to consider as the first degree of this anomaly, the entire separation of the urinary and seminal passages, which has sometimes been observed.

* Dupuytren, *Sur les calcules de la prostate*; in the *Bull. de la fca. de méd.* vol. vii., p. 135.

† Sixtus, *De diffisione genitalium,* Wurtzburg, 1813.

‡ Bamberger, *De intussusceptione membranæ urethræ internæ.* Wurtzburg, 1795.

When the organ is perfectly double, the two penises are situated one at the side of or one above the other. This last anomaly presents a remarkable analogy with the doubling of the tongue, the organ which corresponds to the penis. The first might be regarded as a greater development of the fissure of the penis.

The consecutive deviations of formation comprehend the unusual enlargement of the penis, which commonly supervenes after the development of accidental formations.

The internal membrane of the urethra is rarely reversed.*

C. MAMMÆ.

§ 2523. The mammæ are sometimes deficient on one side, or on both.

Their unusual smallness in the female and their abnormal size in the male constitute the first degree of hermaphrodism, especially when in the second case they secrete milk.

Sometimes they are multiplied as in the mammalia. In the first degree of this anomaly one mamma has two nipples: next we find several mammæ one above another, two and even three on each side, or on one only.†

B. ALTERATIONS IN TEXTURE.

A. GENITAL ORGANS IN THE FEMALE.

§ 2524. Of all the parts of the genital system, alterations of texture exist most frequently in the ovaries; here too the most different and the most regular new formations appear. The increase in the size of the ovaries must generally be attributed to the formation of these accidental productions, although it is sometimes, especially at first, only simple hypertrophy, either in the whole substance of the gland, or, as is more frequent, of one of its constituent parts, the vesicles. The enlargement of the ovary is often enormous, and to such an extent that the organ has been found weighing fifty-five,‡ eighty-five, and even one hundred and two pounds.§

* Stiebel, *Männliches Hymen*; in the *Deutsches Archiv. für die Physiologie*, vol. viii. p. 207.

† Sometimes the supernumerary mammæ exist in unusual parts of the body. Dr. Roberts mentions a woman in whom a third mamma existed in the groin, with which she suckled several children.

‡ Normand, *Observation sur la transformation d'un ovaire*; in the *Journ. gén. de méd.*, vol. lvi., p. 145.—Valentin, *ibid.*, vol. lviii., p. 218.

§ Van den Bosch, in Voigtel, *Handbuch der pathologischen Anatomie*, vol. iii. p. 511.

The least abnormal formation of this kind is *dropsy of the ovary*.* This state presents some differences. Sometimes, in fact, the liquid is contained in one pouch, sometimes it fills several vesicles, of various sizes. It also differs much not only in respect to quantity, which is often enormous, but also, and even sometimes in the different cysts of the same ovary, in respect to colour, consistence, &c.

The cysts generally adhere to the substance of the ovary; but we frequently also find them entirely loose and very numerous in the cavity of this organ, where they seem to have been produced by an effusion of serum. This morbid alteration depends sometimes on the increase of the vesicles of Graaf, sometimes on a repetition of these vesicles resembling the effects of generation, and consequently in a formation of serous membranes.

Not unfrequently these serous membranes contain fat or adipocire.

Beside the serous membranes, accidental mucous membranes are often developed in the ovaries; these also have the form of cysts, contain a more or less dense fluid, and belong to the class of *atheromata* or *meliccrides*.

Another alteration in texture of the ovary, which frequently is seen alone or attended with the preceding, is the formation of fibrous, fibro-cartilaginous, cartilaginous, or osseous substance, which is frequently developed in very large rounded masses, and also increases the weight and size of the organ. To this we must refer, if not entirely at least in great part, the formations described as steatoma, sarcoma, schirrus, osteo-sarcoma, and ossification of the ovary.

To these abnormal repetitions of normal tissues, which frequently occur also in the other parts of the body, but much less commonly than in the ovaries, we must add another, which is almost if not entirely peculiar to these glands. We mean the hairs and the teeth.† The hairs are much more frequent than the teeth, and are developed in the fat, and the teeth in the midst of cysts filled with a gelatinous mass, so that here the normal type is perfect, both in respect to the organ where the new formation occurs, as in that of the proportional frequency of its appearance.

The nature of the organ in which these productions of bone, hair, and teeth occur, and which is the workshop of generation, the period of life at which they are most frequently developed, the fact that they have often been preceded by coition, finally the numerous cases of ovarian dropsy, have led many physiologists to consider them as the remains of a fœtus which is developed in the ovary. But this

* Fehr, *De virgine, hydrope ovarii laborante*, Strasburg, 1762.—Huth, *Casus virginis hydrope ovarii extinctæ*, Strasburg, 1768.—Murray, *De hydrope ovarii*, Upsal, 1780.—Rossum, *De hydrope ovariorum*, Louvain, 1782.—Julia-Fontenelle. *Analyse de quelques substances contenues dans les ovaires dans certains états morbides*; in the *Archiv. gén. de méd.*, vol. iv., p. 257.

† J. F. Meckel, *Mémoire sur les poils et les dents qui se dévelloppent accidentellement dans le corps*; in the *Journ. compl. du dict. des sc. méd.*, vol. iv, p. 122 and 217.

hypothesis is absolutely inadmissible: for the total disparity often observed in respect to number, form, and size, between these abnormal productions, and the remarkable fact that the hair, the bones, and the teeth are the only parts found thus, while in extraordinary pregnancies all the parts of the fœtus are long preserved, prove also that the act of generation, if necessary to produce them, has not at least given rise to a perfect fœtus, and is confined to developing the parts there found.

Although in many cases the development of these more perfect formations, and also of all other abnormal formations seen in the ovary, undoubtedly arises from a copulation not sufficient to give rise to a normal organism, on account of the unhealthy state of one or of both the parents, their advanced age, or any other cause which weakens in them the power of generation: we cannot, however, admit that the male is necessary to produce them, since they have been found in very young girls, where the genital organs were perfectly untouched, and they have occurred in other parts of the body not only of the female but in the male.

If they are more common and more perfect in the ovary than in any other of the organs, it is because the formative power is more energetic in this gland. We must not conclude from this that the union of the sexes must necessarily have preceded them, and still less are they the remnant of an ovarian fœtus.

The entirely abnormal alterations of texture are much more rare in the ovary, probably for the same cause, and because from the greater energy of the formative power, attempts to create new formations are there more frequently successful.

An extremely rare alteration in respect to form, belonging exclusively to the ovary, and the nature of which has not yet been examined, is a large arborescence, formed of several solid tubercles united by filaments. This anomaly has been observed by Prochaska.*

Otto has seen an analogous production, which was not an inch in size.†

We also have before us two instances, which are recent. In opening the cadaver of a prostitute aged about thirty years, in whom were traces of an inflammation of the ovary, we found the tubes adherent and very thick, and farther the left ovary considerably enlarged, very soft, and changed into numerous eminences of different figures. In another cadaver of a woman forty years old, on the surface of the right ovary were three cysts about four lines in diameter, the inner face of which was very much folded, and presented similar circumvolutions. The first case was very probably the formation described by Prochaska, which perhaps might have appeared in the second, if the cysts had been torn, and their inner face had vegetated.

* *Disquis. organism. anat. phys.*, § 58, tab. v.
† *Handbuch der pathologischen Anatomie*, p. 378, note 3.

§ 2525. Alterations in the texture of the uterus are very frequent.

Among the abnormal repetitions of normal tissues we may mention principally the fibrous, fibro-cartilaginous, or osseous bodies, which must be distinguished from schirrus, although they have frequently been described as such, on account of their hardness.

These productions are rounded, sometimes distinct, sometimes united in great numbers, and adhere but slightly to the substance of the uterus. They generally appear on its external, but sometimes on its internal face, and have a yellowish white tint, and an irregular or more or less evidently fibrous structure. They commonly ossify in some parts, although their volume has no effect on this phenomenon. They then become sometimes extermely hard, so that they are cut with difficulty. They are seen principally about the middle of life in unmarried females who have not borne children.

Hairs and fat are formed more rarely under similar circumstances in the substance of the uterus.

All these formations and even the teeth are sometimes developed also on the inner face and in the cavity of the uterus.*

The circumstances in which they occur in the last two places allow them to be considered as the imperfect products of generation. Those in the substance of the uterus are most frequently developed without the co-operation of the male, although they may be caused also by copulation. In this respect they resemble the abnormal formations of the ovary. It is very curious that the phenomena caused by them in both organs sometimes resemble those of pregnancy.†

Not unfrequently even in these same circumstances other formations are developed in the cavity of the uterus, which may be considered as resulting from an ineffectual effort to produce a new organism, and which resemble either the deciduous membrane, or, when they have the form of thin vesicles filled with a serous fluid, the inner membranes of the ovum.

The entirely abnormal alterations in the texture of the uterus are:

1st. Schirrous and cancerous formations.‡ This alteration does not appear, like the fibrous bodies, in the form of distinct masses; it is formed by a change which generally commences at the lower part of the organ, and which gradually extends to the whole of it. The parts in which it is situated become at first hard, then swell more or less, afterwards suppurate in the same order, and are thus gradually destroyed; abnormal openings are thus formed which communicate with the cavity of the abdomen, the bladder, or the rectum, or with several of these parts at once. Here as in all other cases of this change, the lymphatic system is infected, and death is the necessary consequence.

* See our *Handbuch der pathologischen Anatomie*, vol. i, p. 525-542.

† Cochon-Dupuis, in the *Mém. de Paris*, 1698, p. 339.—A. Monro, *Four cases of the tumefied ovarium*; in the *Med. essays of Edinb.*, vol. vi., p. 278.—In two cases pains supervened; in the first at nine months, in the other at ten.

‡ Patrix, *Traité sur le cancer de la matrice et sur les maladies des voies urinaires*, Paris, 1820.

ll these characters distinguish them from the fibrous and osseous roductions.(*a*)

2nd. Polypi are developed on the inner face of the uterus so freuently that, in twenty cadavers, Portal has found them in thirteen.* hey are distinguished, according to the place where they exist, into olypi of the base, of the body, and of the neck: and according to eir degree of solidity into soft and hard. They vary much in respect number and volume.

The vagina usually participates in the schirrus of the uterus, at ast at its upper part. Polypi also are developed there, particularly its summit, but much more rarely than in the uterus.

Sometimes hairs grow on the inner face of the external labia.

B. GENITAL ORGANS OF THE MALE.

§ 2526. The alterations in the texture of the testicles are princially:

1st. *Induration*, a consequence of inflammation.

2nd. Dropsy of the vaginal tunic, termed *hydrocele*. This disease common. The liquid is commonly serous and limpid; but somemes also instead of serum we find a solid and opaque substance, or hen this liquid is thicker and more viscous than usual, it contains ining laminæ very similar to the fatty substance of cholesterine, but hich differ from it, as their specific gravity is greater, and they ssolve more readily in the alkalies.†

3rd. Ossification, which is situated principally in the epididymis d the vaginal tunic. We not unfrequently find in the albugineous embrane rounded plates of bone and cartilage, which are finally tached, and become loose in the cavity of the vaginal tunic. These oductions are less common in the spermatic cord.

4th. Hairs are very rarely developed in them.

(*a*) Very recently the mollescence of the uterus has been made the subject of earch. In an article on this subject by Dr. Luroth, we make the following tract in regard to this disease:—

He states that mollescence of the uterus is more frequently partial than gene-; it more commonly occupies the internal surface and the cervix, though it casionally extends through the substance of the organ. The mollescence prents several degrees, blending insensibly with each other. In the first, the parts simply softened or very flaccid, generally with serous or sero-sanguineous intration into the interstices. In the second degree, the structure of the uterus is ll farther altered. It will scarcely bear handling without reduction into a pultaous mass. In the third degree, the disorganization amounts almost to a liquetion or reduction of the viscus to an inorganic pulp.

* *Observations sur la structure des parties de la génération dans la femme*; in *Mém. de Paris*, 1770, p. 199.—C. Mayer, *Diss de polypis uteri*, Berlin, 1820.

† Beclard and Cloquet, *Deux observations d'hydrocèles rares*; in the *Bull. de la c. de méd.*, vol. v. p. 38.

5th. The albuminous and tuberculous formations in the substance of these glands are not rare.

6th. We find also schirrous formations, which change into cancer.

7th. Fungous formations.

8th. Cysts filled with a liquid similar to the serum of the blood.

Sometimes, but rarely, calculi form in the seminal vesicles,* or in the prostate gland.† The latter at least are composed of phosphate of lime.

The alterations in the texture of the penis are usually of syphilitic origin, ulcers, warts, &c.

C. MAMMÆ.

§ 2527. The mammæ of the male are subject to but few diseases. The alteration most frequent in those of the female is schirrus. We however designate by this term new formations, however much they differ, for almost all can be developed either alone or with others, in the tissue of the mammary gland.(*a*)

CHAPTER V.

OF THE ABDOMINAL CAVITY.

ARTICLE FIRST.

ABDOMINAL CAVITY IN THE NORMAL STATE.

A. PERFECT STATE.

I. ABDOMINAL CAVITY IN GENERAL.

§ 2528. After describing the digestive, the respiratory, the urinary, and the genital systems, we proceed to the topography of the abdominal cavity,‡ the general characters of which have already been mentioned.§

* Hartmann, *De calculis in vesicula seminali*, Erfort, 1765.

† Pohl, *De calculis in prostata inventis*, Leipsic, 1737.

(*a*) An abnormal formation in the mammæ which is not common is that of hydatids, one case of which is detailed in the *Am. Journ. of the Medical Sciences*, 1825.

‡ Fantoni, *De musculis abdominis, peritonæo, vasis ombilicalibus et omento*, Turin, 1745.

§ *General Anatomy.*

A. COMPOSITION.

§ 2529. The *upper* wall is formed by the diaphragm; the *posterior*, i the centre, by the lumbar vertebræ and the sacrum, on the sides y the psoas magnus and the posterior part of the two broad internal ɔdominal muscles: each side is constituted above by the middle poron of these two muscles, and the posterior part of the obliquus abɔminis externus, below by the ossa ilia and the descending ramus of ıe ischium, the *anterior* by the anterior part of the broad abdominal ıuscles, the rectus, the pyramidalis, the linea alba, the pubis, and its scending ramus. The *inferior* by the muscles of the perineum.

The parts we have mentioned are covered on the inside directly or ıdirectly by the peritoneum.

Hence the abdominal parietes are most solid in the posterior and ıferior parts. We may judge also from the description of the musles which form them, that these also are enveloped in some parts ıore perfectly than in others. In the latter, the muscular layers re thinner and more feeble, or the muscles and their tendons are ere entirely or in great part deficient.

B. FORM.

§ 2530. Considered generally, the form of the cavity of the abdoıen is oval. The umbilicus is situated at about the centre of its anerior face: the half above this cicatrix is a little larger and broader han the lower. The anterior wall is the longest. The sides are very hort and almost straight. The posterior presents inequalities produced y the projection of the lumbar vertebræ and the sacrum. It is conex in the centre, at its upper part, and concave on the sides, partiularly below. The upper and lower faces are more or less concave.

C. DIMENSIONS.

§ 2531. The abdominal cavity is much larger than the thoracic: t is the most extensive of the three splanchnic cavities.

D. CHANGES IN FORM AND SIZE.

§ 2532. As its parietes are formed mostly by muscles, it can vary much in form and size. The most important change is that which occurs regularly and constantly during respiration, and which depends on the alternate contraction and relaxation of the diaphragm. The action of the abdominal muscles also occasionally contract it more or less, to expel the substances contained in the intestinal canal, the uterus, and even in the bladder. The diaphragm and the other abdo-

minal muscles are generally antagonists. Their simultaneous action exerted in straining,* produces the greatest possible contraction.

The abdominal cavity is unusually distended :—

1st. By every thing which normally or abnormally increases the mass or the volume of the parts it contains.

2nd. By the direct accumulation within it of substances of every kind, the origin of which varies infinitely.

In this case all the parts which form its parietes are generally uniformly distended.

§ 2533. Besides the organs we have mentioned above, the abdominal cavity also contains the lower part of the aorta, the ascending vena-cava, the commencement of the thoracic canal, the great iliac trunks, the lower part of the ganglionnary nerve, and the lumbar and iliac plexuses of the last spinal nerves.

All these parts are attached more or less by cellular tissue and in a larger or smaller part of their parietes, especially with the posterior, less to the superior, still less to the inferior, the anterior, and the lower region of the side; the upper region of these latter and of the anterior is entirely loose, except a small portion of the anterior, to which the suspensory ligament of the liver is attached.

Even where there is no continuity between the containing parts and those contained, the external faces of these latter are in direct contact with the internal face of the abdominal parietes, so that these faces can glide or play upon each other.

As to their situation, the parts contained in the abdominal cavity differ principally in this respect, that most of them, viz. the upper region of the genital system of the female, and the whole digestive apparatus except the pancreas and the lower extremity of the rectum, are contained in the peritoneum, while the others, especially the great vascular and nervous trunks, the urinary organs and the lower part of the genital system, are situated out of this membrane.

II. PERITONEUM.

§ 2534. The *peritoneum*,† the largest and the most complex serous membrane in the body, has a fibro-serous structure in some parts. It forms a sac, closed in every part except at the abdominal orifices of

* J. Cloquet, *De l'influence des efforts sur les organes renfermés dans la cavité thoracique*, Paris, 1820.

† Wedel, *De peritonæo*, Jena, 1696.—J. Douglas, *Description of the peritoneum and of that part of the membrana cellularis which lies on its outside, with an account of all the abdominal viscera*, London, 1730.—C. G. Buttner, *De peritonæo*, Konigsberg, 1738.—F. G. Hewsing, *De peritonæo*, Giessen, 1742.—H. A. Wrisberg, *De peritonæo diverticulis, illisque imprimis, quæ per ombilicum et lineam albam contingunt*, Gottingen, 1780.—A. Vacca-Berlinghieri, *Mémoire sur la structure du peritoine et sur ses rapparts avec les viscéres abdominaux*; in the *Mémoires de la soc. méd. d'émul.*, vol. iii. p. 315.—C. J. M. Langenbeck, *Commentarius de structurâ peritonæi, testiculorum tunicis, corumque ex abdomine in scrotum descensu, ad illustrandam herniarum indolem*, Gottingen, 1817.

the two Fallopian tubes, where it is continuous with the mucous membrane of these passages. It covers almost the whole cavity of the abdomen, except at the lowest part of the pelvis, and like all the serous membranes, it covers in two different modes the parts on the surface of which it passes. In fact, 1st, it envelops them all with its external layer, which has the form of a sac, but does not touch them; 2nd, Its inner layer is reflected in several places, and is fitted to the surface of the parts, and forms their external envelop.

Several anatomists assert, that not only the parts enumerated above, but also all those situated in the abdomen, are contained in the peritoneum, which divides into an external and an internal layer to embrace them. This opinion arises from another, that the condensed cellular tissue on the outer face of the peritoneum, is a special fold of this membrane. But we cannot admit it, since this layer is not serous; it exists in every part; it does not come from the division of the proper serous fold of the peritoneum, but it is formed by the scalpel, particularly when the parts are hardened by immersion in alcohol.

§ 2535. Like all serous membranes, the peritoneum is highly extensible, so that it does not tear when suddenly or gradually extended very much. Its solidity in the normal state depends upon this property.

It is not equally firm in every part. The external layer is generally much stronger and thicker than the internal. It is strongest in the lumbar region, and at its lower and anterior part, and is weakest at its upper part.

As its connexions with the abdominal parietes are generally slight, it yields easily when drawn down, so that its situation and its relations with the adjacent parts change in a greater or less extent, when the testicles descend into the scrotum, or when a hernia exists.

A. EXTERNAL FOLD OF THE PERITONEUM.

§ 2536. We may distinguish in the external fold of the peritoneum, four parietes, an anterior, a superior, a posterior, and an inferior, the external faces of which are almost in every part united to the internal face of the abdominal parietes.

A. ANTERIOR WALL.

§ 2537. The anterior wall covers the posterior face of the linea alba, the common anterior tendons of the broad muscles of the abdomen, and the anterior part of the fleshy portion of the transversalis muscle. It is attached rather loosely to the linea alba, adheres intimately to the anterior tendon, and is connected less firmly with the fleshy portion of the transversalis muscle. It is serous only at its lower part: but above it is covered on the outside by a very apparent layer of transverse and strong fibres, entirely distinct from those of the tendons

of the transversalis abdominis muscle, and of the linea alba, and which terminate near the umbilicus by a semicircular edge.

From the bladder to the umbilicus the urachus passes over its internal face, on the sides of which we observe the remains of the umbilical arteries, which separate below, are united in a single cord at their upper part, penetrate from without inward, and thus produce on the inside the prominences which have been called *prolongations of the peritoneum* (*processus peritonei*).

On the inner face of the anterior wall we remark the *suspensory ligament of the liver* (*L. hepatis suspensorium*) which descends from right to left to the umbilicus. It is a considerable triangular fold, expanded like a fan, the posterior edge of which is attached from before backward to the upper face of the liver, where it separates the right from the left lobe, and in the lower and loose edge of which we distinguish the *round ligament of the liver* (*L. hepatis teres*), which extends from the umbilicus to the liver.

B. SUPERIOR WALL.

§ 2538. The posterior wall covers the lower face of the diaphragm, to which it is loosely attached.

Near the posterior edge of the muscle the peritoneum is reflected to the right on the liver, and not only covers the whole of this viscus, but also when it comes to the fissure of the vena-portæ, where it forms as it were a sheath, the fasciculus formed by the union of the hepatic artery, the vena-portæ and the biliary passages, goes on the upper part of the duodenum, to be continuous there with the small epiploon, the great epiploon, and the transverse mesocolon.

The very short fold between the blunt edge of the liver and the upper wall of the peritoneum, is termed the *coronary ligament of the liver* (*L. hepatis coronarium*).

From the right side, between the union of the posterior edge of the liver with the anterior, and the limit of the posterior, superior, and anterior walls of the peritoneum, we perceive a larger fold, which is the *right triangular ligament of the liver* (*L. hepatis triangulare dextrum*).

A similar but much larger fold extends from the posterior edge of the small lobe of the liver, and from its summit, to the posterior wall of the peritoneum; it is the *left triangular ligament of the liver* (*L. hepatis triangulare sinistrum*), which is continuous forward with the superior ligament of the organ.

In the place where the esophagus passes through the peritoneum, in proceeding through the esophageal fissure of the diaphragm, this membrane covers it in every part, and also in the upper part of the stomach. The folds which result from them are termed the *right* and *left phrenico-gastric ligaments* (*L. phrenico-gastricum, dextrum,* and *sinistrum*). The first is continuous with the small epiploon, and the

second with the *suspensory ligament of the spleen* (*L. lienis suspensorium*), which is situated more to the left, between the upper extremity of the spleen and the posterior edge of the upper wall of the peritoneum.

C. POSTERIOR WALL.

§ 2539. The posterior wall descends from the upper and posterior edge of the liver, from the cardiac orifice of the stomach, from the left portion of the small curve of this viscus, and from the upper extremity of the spleen, above the lumbar portion of the diaphragm, then leaves the posterior wall of the abdominal cavity, and goes on the anterior face of the pancreas and duodenum, to which organs it adheres very slightly. After leaving the lower edge of the pancreas, the peritoneum goes downward and forward, and forms the upper layer of the transverse mesocolon, a broad and considerable fold, which receives anteriorly the transverse colon between its two layers, and the inferior layer of which is continuous with the lower part of the posterior layer.

This lower part descends before the aorta, the vena-cava, and the kidneys, to which organs it slightly adheres, and afterwards goes without forming any fold, on the right or left, or at least without producing any except those which are very small, on the ascending and descending portions of the colon, goes also to the right side of the kidney towards the duodenum, the anterior face of which it covers, intimately uniting this whole intestine with the upper extremity of the ascending colon, and after covering all these parts, is continuous with the anterior wall, on the posterior portion of the transversalis abdominis muscle.

Only the lower part of the descending colon and the commencement of the rectum, form a considerable fold on the central part of the psoas magnus muscle, and on the upper part of the sacrum.

In the centre of the posterior wall is a fourth fold, directed obliquely from left to right, it descends from the second lumbar vertebra, and is termed the *mesentery* (*mesenterium*). This fold, the root of which is very narrow, enlarges much at its loose edge, which embraces all the small intestine except the duodenum. It is continuous below with the right mesocolon, and gives off a small triangular prolongation, which serves as a mesentery to the vermiform appendage of the cœcum.

It is continuous above with the centre of the transverse colon.

In this place the two layers of these folds separate, and receive between them the lower part of the duodenum.

D. INFERIOR WALL.

§ 2540. We may consider as the lower wall of the external fold of the peritoneum, the part of this membrane which corresponds to the pelvic region of the abdominal cavity, and term it the *pelvic portion.*

It is attached very loosely to the iliaci muscles, to the lower part of the abdominal muscles, to the levator ani muscle, and the sacral plexus. It is connected forward with the obturator internus muscle and the posterior face of the bladder. It covers posteriorly the upper part of the sacrum, but does not adhere to it strongly, and is reflected inward on the upper part of the rectum.

It covers below in the two sexes, the inner part of the levator ani muscle, to which it is loosely united.

The anterior and posterior halves of this lower wall of the peritoneum, are adapted to each other, between the bladder and the rectum, so that in the male the anterior passes from the bladder upon the seminal vesicles, but does not touch them, and in the female, from the bladder upon the upper part of the vagina, and the lower part of the uterus, which it loosely envelops. Having thus arrived backward, it reunites to the posterior, which comes from the rectum, forming a greater or less cul-de-sac between this intestine and the parts we have mentioned.

This cul-de-sac is limited on the right and left by two longitudinal folds, which extend in the male from the rectum to the lower part of the bladder, in the female from the intestine to the lower part of the uterus, and are termed the *semilunar folds* (*plicæ semilunares*).

These folds are much smaller, and consequently the cul-de-sac is much less distinct from the rest of the peritoneal cavity, the more the rectum and the bladder, or the uterus are distended, because then the peritoneum is enlarged to cover its parts.

The lateral wall of the pelvic portion of the peritoneum, forms in the small pelvis of the female a considerable fold, termed the *broad ligament of the uterus* (*L. uteri latum*). This fold is attached to the upper part of the vagina, to all the lateral wall of the uterus, to the Fallopian tubes, and to the ovaries, closely covers these parts, and lodges between its two folds the vessels and nerves which go to it.

The most important part of the pelvic portion of the peritoneum, is that included between the inner extremity of the iliac crest and the symphysis pubis.*

The peritoneum forms in this place two depressions, which are separated by the umbilical ligament, and by the prolongation of the

* Hesselbach, *Ueber den Ursprung der Leistenbrüche*, Wurzburg, 1806.—Id., *Ursprung und Fortschritte der Leisten-und Schekenlbrüche*, Wurzburg, 1816.—Id., *Disquisitiones anatomico-pathologicæ de ortu et progressu herniarum inguinalium et cruralium*, Marburg, 1816.—R. Liston, *Memoir on the formation and the connections of the crural arch and on the parts contained in inguinal and crural hernia*, Edinburgh, 1819.

peritoneum which surrounds it, and which may be termed the *inguinal fossæ;* they are distinguished into *external* and *superior*, the large, and *internal* or *inferior*, the smaller. At the place where the inguinal canal commences, we usually observe in the peritoneum a small depression, which is often connected with a cord formed of cellular tissue, which passes through this canal. This depression frequently forms a greater or less sac. It is always a remnant of the prolongation which formerly extended from the peritoneum into the scrotum.

The external inguinal fossa represents a pyramid, situated between the peritoneal prolongation and the commencement of the inguinal canal. The internal is adapted on the median line to that of the opposite side, from which it is always more or less completely separated by the projection of the urachus. It corresponds directly to the inguinal ring.

B. INTERNAL FOLD OF THE PERITONEUM.

§ 2541. The internal fold of the peritoneum which covers the outside of the parts situated in the cavity of the abdomen, is much thinner than the external. It is not arranged exactly in the same manner in regard to all the parts it covers, for it is attached directly to some, and to others only by more or less considerable prolongations. In several portions it extends on the almost loose part of the surface of the organs, and forms prolongations, which are sometimes loose and floating, and sometimes contribute also to unite one organ with another, independent of the common envelop.

All these internal prolongations of the peritoneum, whatever be their relation with the organs, are formed of two layers, all the corrugated faces of which adhere to each other, while the smooth faces are loose and turned outward. We may then term them generally the *folds of the peritoneum.*

The folds between the external layer of the peritoneum and the intestinal canal, are termed the *mesenteries* (*mesenteria*).*

Those which are shorter but broader, and which exist between the external fold of the peritoneum and the other parts, particularly the stomach, liver, spleen, &c., are termed the *ligaments of the peritoneum* (*L. peritonei*). Their names are derived sometimes from their form, and sometimes from the parts which they unite. We have already mentioned most of them, in describing the external layer: and shall return to them when speaking of the epiploon.

The folds which extend from one viscus to another, are the *epiploa* (*omenta, s. epiploa*).†

* J. S. Henninger, *De mesenterio*, Strasburg, 1714.—J. Fantoni, *De mesenterio, vasis chyliferis et lymphaticis*; in the *Diss. anat. renov. V.*—Stock, *De statu mesenterii naturali et præternaturali*, Jena, 1755.—M. Malpighi, *De omento, pinguedine et adiposis ductibus*; in *Opp. omn.*, vol. i. p. 227.

† Henrici, *Diss. sistens novum descriptionem et iconem omenti*, Copenhagen, 1758.—Haller, *Omenti nova icon.*; in the *Icon. anat. fasc. I*, and *opp. min.*, vol. i.

Those which only project on the surface of a viscus, are termed the *epiploic appendages* (*appendices epiploicæ*).

The last two kinds of folds differ from all others, as they are extremely thin, so that many anatomists have even considered their reticulated or perforated structure as a normal arrangement.

A. MESENTERIES.

§ 2542. The best mode is to commence the history of the folds of the peritoneum by that of the mesenteries.

a. Mesentery.

§ 2543. The *proper mesentery* (*mesenterium*) is directed obliquely from above downward, and from right to left; it extends from the left side of the body of the second lumbar vertebra, to the right sacro-iliac symphysis.

It is composed of two layers, a right and a left, which are separated in the upper two thirds of the mesentery, by the third or the ascending portion of the duodenum, but which unite beyond this portion, and in the lower third of the mesentery.

The posterior edge, which rests on the vertebral column, is termed the *root of the mesentery* (*radix mesenterii*). It is much shorter than the anterior, by which it is attached to the small intestine, so that its layers separate on arriving at the intestine, which they receive between them, and narrowly embrace them in all their extent.

The mesentery enlarges imperceptibly from its upper and lower parts, to its centre. Its greatest breadth is about four inches.

Between the two layers which compose it, and which are easily separated, are cellular tissue, fat, lymphatic ganglions, blood-vessels, lymphatic and chyliferous vessels, and nerves.

It is continuous at its upper extremity with the transverse mesocolon, at the lower, with the triangular mesentery of the vermiform appendix of the cœcum, which is attached to the left side of its circumference, and the left side of which is perfectly loose, and continuous with the ascending mesocolon.

b. Mesocolon.

§ 2544. The colon is not, like the small intestine, attached to the posterior wall of the abdominal cavity by a very long fold, which per-

—Reebmann. *De omento sano et morboso*, Strasburg, 1753.—P. Van Næmer, *De fabrica et usu omenti*, Leyden, 1764.—Chaussier, *Essai sur la structure et les usages des épiploons*; in the *Mém. de l'ac. de Dijon*, 1784.—Froriep, *Neue Darstellung der Gehroses und der Netze*, Weimar, 1812.

its it to float freely. On the contrary, it is attached more firmly nd immovably by the mesocolon.

After covering the centre of the duodenum on the right side, the osterior wall of the peritoneum goes on the ascending portion of the olon, and covers it anteriorly, but not posteriorly, or at least but ery rarely, where it is exposed on the anterior face of the kidney. Even when the ascending colon is entirely enveloped by the peritoeum, the fold which attaches it is always very short.

The cœcum is most generally attached rather more loosely to the pper part of the iliacus muscle.

There are often detached from its summit two triangular folds, irected from right to left, and from above downward, which leave etween them a depression, the base of which is formed by the iliacus nuscle and the cœcum, and into which, particularly when the cavity s considerable, a greater or less portion of the intestine enters and s strangulated.

The *transverse mesocolon* (*mesocolon transversum*), which is uninerruptedly continuous with the ascending mesocolon, is an elongated uadrilateral fold, about four inches high, which extends from right o left near the centre of the abdominal cavity, and which is much igher in the centre than on the sides.

It arises on the right from the centre of the duodenum, in the entre from the anterior face of the pancreas, often also from the ight side of the posterior face of the stomach, farther, and towards he left, from the extremity of the duodenum, and is attached to the ransverse colon by its anterior edge.

At its commencement on the right on the duodenum, it is continuus above and below with the portion of the posterior wall of the eritoneum, which covers the duodenum anteriorly, and intimately unites this intestine to the colon.

Farther on the right, its upper layer closely unites with a greater r less portion of the great epiploon, so that hence, a quadruple layer rom the duodenum to a greater or less portion of the right half of the reat curve of the stomach exists, and this union of the right edges f the great epiploon and transverse mesocolon, always closes in this lace the sac formed by these two folds.

It imperfectly divides the internal fold of the peritoneum into two alves, a superior, smaller, and an inferior, which is larger.

The *descending mesocolon*, the direct continuation of the preceding, s quadrilateral at its upper part, and does not generally surround the vhole circumference of the descending colon. It arises from the ipper part of the anterior face of the left kidney, but comes also in ts centre, where it is more extensive, from the anterior fold of the osterior tendon of the transversalis abdominis muscle, finally below where it is larger than in any other part, and often also as broad as he transverse mesocolon, from the left psoas muscle and the sacroliac symphysis of the same side.

A small part of the upper portion of the rectum is attached to the anterior face of the sacrum by a short fold of the peritoneum, termed the *mesorectum.*

B. EPIPLOA.

a. Great epiploon.

§ 2545. The *great epiploon, epiploon gastro-colique,* descends by its upper edge:

1st. From the lower part of the fissure of the spleen, and from its lower extremity, where it is united with the gastro-splenic ligament.

2nd. From all the great curve of the stomach.

3rd. From the commencement of the duodenum.

It is adapted to the anterior part of the circumference of the transverse colon, goes before the small intestine, and generally descends into the pelvis, where it terminates by a loose edge.

Its straight edge unites with the transverse mesocolon, and is attached by the left to the lower extremity of the spleen, and also to the left extremity of the pancreas and the transverse colon, uniting with the posterior wall of the peritoneum.

b. Small epiploon.

§ 2546. The *small epiploon, epiploon gastro-hepatique* (*epiploon hepatico-gastricum*), descends from the fissure of the venous canal, from the left portion of the fissure of the vena-portæ and the capsule of Glisson, towards the small curve of the stomach, from the cardiac to the pyloric orifice, and floats before the lobe of Spigel.

The two epiploa communicate by the portion of the peritoneum which covers the anterior and posterior faces of the stomach, and thus forms, with the stomach, the anterior wall of a sac, the lower wall of which is constituted by the transverse cōlon and the transverse mesocolon, and the posterior by the upper part of the posterior wall of the peritoneum.

The upper part of this sac, which is placed between the liver and the small curve of the stomach, communicates with the inferior, situated between the small curve and the transverse colon, by a greater or less opening, which is found between the posterior wall of the stomach and that of the peritoneum, in the part where the small curve of the stomach, near its right extremity, is not attached to the posterior wall of the peritoneal sac.

The whole sac or the cavity of the epiploon communicates with the peritoneal cavity by the *foramen of Winslow* (*foramen Winslowii*), a rounded, oblong opening, situated on the right side of the abdomen, bounded on the right by the fissure of the vena-portæ, forward by the

fasciculus formed by the vena-portæ, the hepatic artery, and the biliary passages, on the left by the first curve of the duodenum, and below by the posterior wall of the peritoneum, which the ascending vena-cava covers in this place

When we separate the liver and duodenum, and consequently remove from this latter organ the portion of peritoneum which extends from its summit to the liver, in forming a sheath around the fasciculus we have mentioned, a more or less broad, semicircular fold is formed, having its loose edge turned downward; this is termed the *hapato-duodenal* ligament (*L. hepato-duodenale*).

We may produce also in the same manner an analogous fold between the first curve of the duodenum and the upper extremity of the right kidney. This last fold is the *duodeno-renal* ligament (*L. duodeno-renale*).

The foramen of Winslow is situated between these two folds.

c. Epiploic appendages.

§ 2547. The *epiploic appendages* (*Appendices epiploicæ*) are short prolongations of the peritoneal tunic of the large intestine; they are rounded, oblong, varying in breadth, filled with fat in fleshy people, and with a reddish, gelatinous liquid in lean persons. They arise principally from the anterior side of the edge of this tunic.

They are observed along the whole length of the colon, but they are not arranged exactly in the same manner in all parts of this intestine.

They always receive a considerable vascular branch, which comes from the mesocolon.

They are generally arranged in two rows.

These rows are situated on the outside and the inside of the intestine in the lower portion of the descending colon, on the lower edge in the transverse colon, finally on the internal and anterior edge in the descending colon.

In this latter point one of the two rows, the longest, is much nearer the intestinal extremity of the mesocolon than in the ascending colon.

In the ascending colon, the epiploic appendages receive the external and internal branches of the mesenteric vessels. In the rest of the colon their vessels come only from the lower and internal branches of those of the intestine.

The mesocola from also at intervals near the intestine similar prolongations, which are directed from above downward.

B. PERIODICAL DIFFERENCES.

I. REGULAR AND GENERAL DIFFERENCES.

§ 2548. Ist. The abdominal cavity is much larger in proportion to the chest, during the early periods of existence, than when the subject is fully grown, but its pelvic portion is infinitely smaller.

2nd. Until the third month of pregnancy it extends by means of a prolongation, the length and the breadth of which are in direct ratio with the youthful age of the new being, and which encloses a portion of the intestinal canal, with the umbilical and omphalo-mesenteric vessels, in the umbilical sheath formed by the inner membrane of the ovum, so that this sheath then really makes part of it. The anterior cavity is covered by a prolongation which is also reflected on the viscera which it contains.

In the fœtus of three months, the anterior wall of the peritoneum extends already on the opening of the umbilicus, through which the umbilical vessels enter and depart, but does not give off in this place a prolongation which penetrates into the cord.

We do not perceive at first any well marked difference between the general ligaments and the umbilical sheath; but this difference is seen in proportion as the development of the skin progresses. Hence in the full-grown fœtus the root of the umbilical cord is surrounded by a cylindrical fold of skin, which is about four lines long, and is usually more distinct from the umbilical sheath on the right side than the left,* the inner face of which is strengthened by some fibres of the linea-alba.

The umbilical ring is much broader the younger the fœtus is. It gradually contracts, and in the full-grown fœtus it exactly surrounds the umbilical vessels. Its lower part particularly is intimately united with the umbilical artery by a short and firm cellular tissue; the cellular tissue which unites the upper with the umbilical vein is looser. The umbilical ring is already surrounded in the full-grown fœtus with very strong and perfectly developed tendinous fibres, while the linea alba, less advanced in all these respects, is formed only of indistinct and proportionally shorter and narrower tendinous fibres.

After birth the portion of the cord left on the body of the infant dies in its whole extent where it is covered by the umbilical sheath. Instead of the cylindrical fold of skin, there forms a depressed cicatrix, the *navel* or *umbilicus*, the depression of which depends principally on the disappearance at this period of the prominence previously formed by the umbilical vessels and the gelatine of Wharton.

* Sœmmerring, *Ueber Nabelbrüche*, Frankfort, 1811, p. 7

It depends also on the general law that the cicatrices of the skin are ttended with a greater or less contraction. The collapsing of the mbilical vessels also assists to form it. Afterward the depression ıcreases as much more as there is fat deposited in the surrounding arts, for this fluid never accumulates in the cicatrix.

The umbilical ring and the peritoneum gradually adhere very intiately with the cellular tissue and the skin which covers them. In ıe book on embryology we shall mention the changes in the umbical vessels.

3rd. In the male and female fœtus, the peritoneum forms another ıl-de-sac, the *diverticulum of Nuck* (*diverticulum Nuckii*), which exnds through the inguinal canal and inguinal ring. This divertilum is connected with the development of the testicle in the male. has even the same use in the female, but as it here receives no gan it is much narrower and shorter, and often disappears before e end of the last month of pregnancy.

The great epiploon appears in the second month of pregnancy. ntil the fourth there exists only a simple prolongation of the periıeal coat of the stomach, which is not yet connected with the transrse colon.

The epiploic appendages of the large intestine appear at the fifth onth of pregnancy.

II. ACCIDENTAL DIFFERENCES.

§ 2549. The abdominal cavity is considerably distended during gnancy: but it returns almost entirely to its normal dimensions er parturition. We have not observed any marked difference her in the region of the umbilicus or in other parts, even in those ıales who have had several children, nor has Sœmmerring.* But skin being much less extensible, wrinkles are formed in the ıeral integuments of the abdomen by pregnancy, which are not n in females who have had no children.

C. DIFFERENCES RELATIVE TO SEX.

2550. The abdominal cavity is smaller in proportion to the st in the male than in the female, in whom it is much longer and rower at its upper part, but much broader in the lower, that is, ts pelvic portion. The hairs of the pubis also differ in their ıngement. In fact in females they suddenly cease, and occupy the centre of the space between the umbilicus and the symphysis is, while in the male they extend in a point to the umbilicus.

* *Loc. cit.*, p. 25.

ARTICLE SECOND.

OF THE ABDOMINAL CAVITY IN THE ABNORMAL STATE.

A. DEVIATIONS OF FORMATION.

§ 2551. 1st. When the upper half of the body is not perfectly developed, in acephalia vera, the abdominal cavity presents more or less the same deviation of formation at its summit, so that sometimes only the pelvis portion exists, and this also is frequently narrower than in the normal state.

In other cases, on the contrary, tumours, congestions, liquids, &c., often distend it very much.

2nd. Curvature of the spine, which sometimes, but very rarely, constitutes a primitive deviation of formation, naturally causes a greater or less alteration in the form of the abdominal cavity and the situation of the parts within it.

3rd. This cavity not unfrequently presents anomalies depending on the permanence of one of the degrees of formation through which it successively passes, that is, the openings and prolongations first existing at its upper or lower extremity do not disappear in a greater or less portion of their extent. This causes congenital umbilical hernia, and the abnormal communication between the viginal tunic of the testicle and the cavity of the peritoneum, which give rise to congenital inguinal hernia.

Frequently also the connections of the abdominal parietes with the parts contained in this cavity, particularly those of the external and internal layers of the peritoneum, are abnormal.

This abnornal state is sometimes, but rarely, the effect of a primitive deviation of formation. It is generally consecutive.

It is much more common to observe unusual connections, adhesions, which are generally the consequence of an inflammation of the peritoneum, and which are caused by effusion. Sometimes even in this case all the organs surrounded by the peritoneum are so blended in one mass that they cannot be perfectly separated; but they generally adhere only in some parts.

Solutions of continuity are very rare, and generally constitute primitive deviations of formation.

If the adhesions occur so that they produce a kind of bridge between the two parts, this arrangement may induce in the cavity of the abdomen the same consequences as certain solutions of continuity, as an opening also results from them; but this is a subject naturally connected with that of internal hernias, of which we shall speak hereafter.

4th. The abdominal viscera are not unfrequently displaced. Most

of these displacements are termed *hernias*,* which term includes every abnormal situation of a viscus which leaves the cavity in which it is normally situated, or which enters into a generally abnormal compartment of the cavity in which it is situated.

The first case constitutes the *external*, and the second the *internal* hernias.

I. EXTERNAL HERNIAS.

§ 2552. The most important points in the history of hernia are, the relations of the displaced parts with the integuments, the nature of the herniary parts and the changes in them, finally the place where the hernia occurs, and the peculiar phenomena presented by each species of hernia in the first two respects.

1st. *Nature of the envelops.* Beside the integrity of the common integuments, which occurs first in most hernias, the most general condition of this anomaly is the existence of a herniary sac, produced by the elongation of the peritoneum.

The internal hernias differ in this respect from the external: for the parts which have passed through an abnormal opening in the cavity of the abdomen are not surrounded with a herniary sac. Besides sometimes we find no sac in the external hernias, whither it has never existed, as when the peritoneum is torn, or it has been destroyed by compression, suppuration, or gangrene.

The herniary sac is principally deficient in phrenic hernia, from a rupture of the peritoneum.

On the other hand the peritoneum and the cellular tissue which surrounds it externally gradually thicken and become harder to some extent, particularly at the entrance or neck of the herniary sac, which happens particularly after long compression.

Not unfrequently also inflammations arise from the prolongations which extend from one point of the circumference of the herniary sac to the others.

2nd. *Nature of the abdominal organs which form the hernia.* We must consider here the quality of the organs, their state, and their relations with the herniary sac.

a. Hernia is most generally formed by a portion of the small intes-

* J. G. Gunz, *Observationum anatomico-chirurgicarum de herniis libellus*, Leipsic, 1744.—G. Vogel, *Abhandlung aller Arten der Brüche*, Leipsic, 1756.—P. Pott, *Treatise on ruptures*, London, 1756.—J. T. Klinkosch, *Programma quo divisionem herniarum novamque herniæ ventralis speciem proponit*, Prague, 1764.—Arnaud, *Mémoires de chirurgie*, London, 1768, vol. ii.—A. T. Ritcher, *Abhandlung von den Brüchen*, Leipsic, 1778.—Monteggia, *Quædam de hernis*; in the *Fasc. anat. path.*, 1793.—J. and C. Wenzel, *Eilf Beobacktungen ueber Brüche*; in Loder, *Journal für Chirurgie*, vol. iii. pt. ii. 1800, p. 217-258.—A. Monro, *The morbid anatomy of the human gullet*, p. 363-512.—J. F. Meckel, *Handbuch der pathologischen Anatomie*, vol. ii. pt. i. 358-484.—A. Scarpa, *Traité pratique des hernies*, Paris, 1812-1823.—Lawrence, *Traité des hernies*, Paris, 1818.—J. Cloquet *Recherches anatomiques sur les hernies de l'abdomen*, Paris, 1817-1819.—Breschet *Essai sur la hernie fémorale*, Paris, 1819.

tine or of the epiploon, more rarely by a portion of the large intestine, still more rarely by the liver or a portion of the urinary or genital organs. We, however, possess several instances of hernia of the uterus, the ovaries, the Fallopian tubes, and the bladder. An intestinal hernia usually includes all the circumference of the intestine. We rarely find in it only a portion of the surface of the organ.

b. The herniary parts are abnormal, either in respect to their situation only, or also in their functions and texture. This latter case happens particularly when, from a want of proportion between the capacity of the herniary sac and the volume of the part displaced, this latter is compressed, strangulated, whence it inflames, and even becomes gangrenous when the disproportion continues. If gangrene occurs, the herniary portion is separated from that which is contained in the abdominal cavity, which causes, when hernia of the intestine exists, the formation of an abnormal opening termed an *artifical anus.* Some and even large portions of the intestinal canal may be destroyed, although no fæces escape into the abdomen, and without the close of the natural opening. This close in fact occurs sometimes from the effusion of fibrin all around the opening produced by the gangrene, which is obliterated at first on the side of the cavity of the intestine, then externally. It occurs even in some cases where there was not the least direct communication between the upper and lower ends of the intestine.

c. The herniary parts do not generally adhere at first to the herniary sac, excepting their envelops, as when, for instance, in the hernias of the ascending or descending colon, the displaced part is primitively united to the sac: but afterward, exudation which succeeds inflammations of the serous membranes so rapidly, causes the serous membrane of the herniary sac to adhere more or less intimately with the displaced viscus. The hernia is then said to be *adherent.*

3rd. Certain regions of the abdomen are more subject to hernias than others; particularly those which have a sloping situation, and which on account of their structure, are but slightly resisting. The most common hernias are *bubonocele* and *merocele*, which take place, one through the inguinal ring, the other through the crural arch. The inguinal hernias become *scrotal* when these viscera descend into the scrotum. The bubonocele is more common in males, and the merocele in females. Next come the *umbilical* hernias, then the *ventral,* next those through the *foramen ovale,* then the *phrenic,* and lastly the *ischiatic* and the *lumbar.*

a. In *inguinal* hernia, the viscera always emerge through the inguinal ring, but do not always come there in the same manner. In the *external* or *oblique* inguinal hernia, which is infinitely more common than the other, the viscera emerge through the inguinal canal, so that the tumour has at first an oblique direction; on the contrary, in the *internal* or *right* inguinal hernia, it proceeds directly from above downward, towards the ring on the inside of the old umbilical artery, and passes through or distends the lower part of the broad internal

ɔdominal muscles which are situated before it. Hence the differences :tween these two hernias, in respect to their envelops and the rela- :ons of the tumour with the adjacent parts.

The external inguinal hernia is inclosed in all the envelops of the ermatic cord, consequently, in the cremaster muscle and the com- on vaginal tunic. The spermatic cord is situated behind the tumour, ıd follows the same direction. The epigastric artery is reflected ›m without inward, and from below upward, behind this tumour. ıe form of the hernia is oblong, at least at first.

The internal inguinal hernia is not generally enveloped by the emaster muscle and the vaginal tunic, but only by the cellular tissue the scrotum. It is situated on the inside of the cord, does not pass fore it, and sometimes is found behind it. The epigastric artery :cends at its inner side, and its form is rounder.

Although these differences occur generally, the rule is however bject to exceptions. Thus in one case, the cremaster muscle evi- ntly passed on the anterior face of an internal inguinal hernia.* another case, the spermatic cord proceeded transversely on the ck of an internal hernia, towards its inner side, and farther, near posterior side.† Finally, in a third, the epigastric artery ascended t the inside of the tumour.‡

Congenital hernia is a variety of external inguinal hernia, in which : viscera descend in the unobliterated prolongation of the perito- ım, and are consequently situated in the same cavity as the testicle, ich even sometimes adheres to them before leaving. We must › compare with external inguinal hernia, that recently described he *infantile* hernia, where the displaced viscera are engaged in vaginal tube. This hernia may present two forms. Sometimes fact, the vaginal tube is open its whole extent, both on the side o testicle and that of the abdomen, and sometimes only on one side. the first case the herniary sac does not touch the testicle, as does organ displaced in congenital hernia. In the second, when the inal tube is open at its upper part, the hernia is enveloped by a ond sac, which forms it, exactly as in any hernia, the part con- ıed in the sac is by this sac. When, on the contrary, the tube is ;ed above, the sac occupies also the upper part of the vaginal ic, but in a still more complex form, since this tunic sends to it › envelops, an external and an internal.

The external is arranged as in the second case, and the relations of vaginal tube are not changed. The internal, on the contrary, is hed back at its upper part, and reversed by the hernia, whence in case the sac is smooth externally. We conceive that in all these :s the number of the envelops of the hernia is augmented, and it is really provided with a double sac. In the first it may be

Todd, *On hernia*; in the *Dublin hospital reports*, Dublin, 1817, vol. i. p. 231.
Ibid.
Hesselbach, *Leisten-und Schenkelbruche*, Wurzburg, 1815, p. 45.

complicated with a common congenital hernia; in the second also, two hernias may coexist.*

Inguinal hernia is much more common in the male than in the female, because the inguinal ring is broader in the male, and the vaginal prolongation remains open much longer in him.

b. *Crural hernia* takes place below the crural arch. It is rounded, and is generally situated on the inner side of the crural vessels, before the epigastric artery, usually also before the obturator artery, even when the latter comes from the epigastric artery, sometimes, however, behind it. Its neck is situated in the male directly below the upper part of the spermatic cord; in the female below the lower part of the round ligament of the uterus. It is more common in the female than in the male, on account of the greater distance between the symphysis pubis and the anterior extremity of the iliac crest.

c. *Umbilical* hernia occurs either through the umbilical ring, or in its neighbourhood, through a fissure in the linea alba. The first case is the most common when the tumour exists as soon as the child comes into the world, and depends on suspended development. The second is still more so when the hernia is formed there accidently. It frequently has a rounded form, and is rarely oblong.

d. *Ventral* hernias are observed principally in the epigastric and the inguinal region, around the ring.

e. *Ovular* hernia† occurs through the space at the upper and outer part of the foramen ovale. It is then situated very deeply before the obturator vessels and nerves, below and behind the adductor muscles of the thigh.

f. Phrenic hernia‡ supervenes in very different parts of the diaphragm, and it is destitute of a sac more frequently than any other hernia. It is congenital much more frequently than accidental, which undoubtedly depends on the necessity of extreme violence to produce it, for since when it occurs the viscera are displaced in a direction opposite to their weight.

g. and *h.* Hernias through the sciatic notch and the lumbar region, are extremely rare. The second has no peritoneal envelop, and is generally formed by the kidneys.

II. INTERNAL HERNIAS.

§ 2553. The *internal hernias*§ are occasioned by abnormal openings, or by culs-de-sac existing in the cavity of the abdomen.

1st. Abnormal openings exist sometimes in the internal portion of the peritoneum, that which always occurs, and sometimes form after partial adhesions between parts which should be separated.

* We have enlarged a little on this subject, because it does not seem completely exhausted by Todd's remarks, since the publication of our *Handbuch der pathologischen Anatomie*, vol. i. pt. 2. p. 416.

† Buhle, *De herniâ obturatoria*, Halle, 1819.

‡ Zwanziger, *De herniâ diaphragmaticâ*, Halle, 1819.

§ Meyer, *De strangulationibus intestinorum in cavo abdominis*, Strasburg, 1776.

The openings of the first kind, which are more rare, occur principally in the mesentery.*

Those of the second class may be developed in all parts. We have observed almost all of them in cadavers. The partial adhesions which give rise to them, may take place,

a. Between several portions of the intestine.

b. Between the small intestine and the anterior edge of the liver.

c. Between the upper face of the liver and the upper wall of the peritoneum.

d. At the summit of a diverticulum of the ileon, especially by a filament which still exists there, and which is formed by the remnant of the omphalo-mesenteric vessels.†

e. Between the vermiform appendix of the cœcum and a portion of the mesentery, the intestinal canal, and the uterus.‡

f. Between the epiploon and the base of the uterus, or any other abdominal organ, or even the parietes of the peritoneum. It is the most common of all the adhesions.§

g. Between the ovary, especially when it is enlarged, and the base of the uterus.

2nd. Abnormal depressions are formed by the mesentery,|| the bladder,¶ the vagina.** In the last case the bladder is situated in the wall of the vagina, particularly the anterior, which is then turned over.††

We conceive that these parts, which are then lodged in one of these depressions, can undergo the same changes as in an external hernia.

B. ALTERATIONS IN TEXTURE.

§ 2554. We ought to mention particularly the alterations in the texture of the peritoneum,‡‡ and which are common to it with the other serous membranes.

* Heuermann, *Chir. operat.*, vol. i. p. 627 —Saucerotte, in the *Mém. de l'ac. de chir.*, vol. iv. p. 239.—Monro, *Anat. of the gullet*, p. 537.

† Van Dœveren, *Annot. acad.* V.—Monro, *loc. cit.*, tab. xx. p. 538.

‡ Monro, *Phys. essays of Edinb.*, vol. ii. p. 402.—Otto, *Pathol. Anat.*, p. 280.

§ Ruysch, *Obs. anat.*, p. 65.—Monro, *Anat. of the gullet*, p. 533.—J. P. Weidmann, *Memoria casus rari in gynæceis præcipue adnotandi; cum uteri anticâ facie omenti margo ex aliquâ parte coalverat; prægnans fœtu, medium graviditatis non assecuta, inopinato moritur*, Munich, 1818.—Gartshore, in the *Med. obs. and inq.*, vol. iv. p. 223.—Haen, *Rat. med.*, pt. ii. c. iii. § 2.—Knoblauch, *Diss. de entero-mesorolocele*, Leyden, 1767.

|| Neubauer, *Descript. anat. rarissimi peritonæi conceptaculi tenuia intestina a reliquis abdom. visc. seclusa tenentis*, Jena, 1776.—Van der Kolk, *Diss. exhibens observ. varii argumenti*, Groningen, 1793.—Lawrence, *loc. cit.*

¶ Meckel. *Handbuch der pathologischen Anatomie*, vol. ii. p. 467.—Cooper, *Ueber Brüche*, p. 96.

** Meckel, *Handbuch der pathologischen Anatomie*, vol. ii. p. 450.

†† Clarke, *Diseases of females*, tab. iv.

‡‡ J. G. Walter, *De morbis peritonæi*, Berlin, 1787.—Goelicke, *De mesenterii affectibus*, Halle, 1742.—Stock, *loc. cit.*—Reebmann, *loc. cit.*—Halder, *De morbis omenti*, Gottingen, 1786.—A. Portal, *Observations sur les tumeurs et engorgemens de l'epiploon*; in the *Mém sur plus. maladies*, vol. i. 1800, p. 67.—Scou-

This membrane is frequently inflamed in a greater or less extent, and thus more or less broad and firm adhesions are formed. Inflammation of it also produces either in its external or internal layer, an induration, a thickening which is often very great, several lines in extent. This alteration is caused particularly by a long continued inflammation. We may also mention another which depends on the same cause, and is almost peculiar to the peritoneum: it is the development on its inner face of numerous small miliary elevations.

The abdominal cavity is very frequently the seat of dropsy, which is there called *ascites*. Serum most generally occupies the whole cavity: in some cases only the epiploa are filled.

Sometimes considerable masses of fat are developed on the inner face of the peritoneum, even in persons not very fleshy. The great epiploon, particularly, presents frequent instances of this anomaly, and it has then weighed thirty pounds.*

Ossifications on the external face of the peritoneum are rare: but we frequently see them at intervals on its internal face, particularly on the surface of the spleen. The epiploon sometimes presents a similar formation.†

Rounded, cartilaginous, and osseous masses, similar to those found loose in the articulations, are rarely developed on the inner face of the peritoneum: they finally become loose, leaving their attachments.

Hairs occur in the epiploon still more rarely.

We not unfrequently find on the two faces of the peritoneum, and in the epiploa, serous cysts, and larger or smaller masses of hydatids. The serous cysts also are sometimes detached and become loose.‡

The external, and more frequently the internal layer, particularly the epiploa and the mesenteries, also are frequently the seat of accidental formations, of more or less solid whitish substances, which are described as atheromata, steatomata, &c., and which frequently become heavier than the fatty tumours mentioned above.

Ruptures of the reservoirs in the abdomen produce effusions into its cavity of bile, blood, or of the contents of the intestines or the uterus.

The air which sometimes fills the cavity of the peritoneum, or only that of the epiploa, comes from the same source in some cases. But probably this is not always its origin, for sometimes, although very rarely, this fluid is exhaled by the vessels, the action of which is changed.

tetten, *Mémoire sur l'anatomie pathologique du péritoine*; in the *Archiv. gén. de méd.*, vol. iii. p. 497; vol. iv. p. 386; vol. v. p. 537.—D. V. Van Leuwen, *De peritonæo ejusque inflammatione*, Utrecht, 1819.

* Portal, *Anat. méd.*, vol. v. p. 127.

† Mongin, *Sur la pétrification de l'épiploon*, Paris, 1735.

‡ Desbas, *De hydrope peritonæi saccato*, Gottingen, 1761.

BOOK VII.

EMBRYOLOGY.

§ 2555. When all the parts of the body have acquired their respective and normal proportions, and the genital organs also are perfectly developed, the individual is fit to propagate the species by connection of an individual of the other sex. In describing the perfect state of the genital system, we have already mentioned the conditions on the part of these organs, in order that coition may be productive. The connection of the two sexes causes in the female those changes which result in producing a new organism, and which is termed *conception.**

CHAPTER I.

CONCEPTION IN THE NORMAL STATE.

§ 2556. Before detailing the phenomena presented by conception we must establish the following corollaries:

1st. *The fœtus is produced, and not merely developed*, since we perceive no trace of it before coition followed by impregnation.

* The works we shall mention treat more or less perfectly of the changes in the organism of the female and of those in the new being:—J. C. Aranzi, *De humano fœtu libellus*, Venice, 1751.—Fabrice of Aquapendente, *De formato fœtu*, Padua, 1604.—G Harvey, *Exercitationes de generatione animalium*, London, 1651.—C. Drelincourt, *De conceptû*, Leyden, 1685.—M. R. Besler, *Admirandæ fabricæ humanæ muliebris partium generationi inservientium et fœtus fidelis quinque tabulis hactenus nunquam vivis, delineatio*, Nuremberg, 1640.—Haller, *Historia nuperiæ dissectionis feminæ gravidæ*, Gottingen, 1734.—G. Noortwyk, *Uteri humani gravidi anaotme et historia*, Leyden, 1743.—D. Monro, *The dissection of a woman with child, and remarks on gravid uteri*; in the *Ed. phys. and liter. essays*, vol. i., art. 17.—A. Monro, *Additional observations on gravid uterus*; ibid., art. 18.—J. G. Rœderer, *Icones uteri humani observationibus illustratæ*, Gottingen, 1759.—C. N. Jenty, *Demonstratio uteri prægnantis mulieris cum fœtu ad partum matur.*, Nuremberg, 1761.—Azzoguido, *Observationes ad uteri constructionem pertinentes*, Bologna, 1773.—G. Hunter, *Anatomia uteri gravidi tabulis illustrata*, Birmingham, 1774.—E. Sandifort, *De utero gravido*; in the *Obs. anat. pathol.*, vol. ii. Leyden, 1778.—J. Burns, *Anatomy of the human gravid uterus*, Glasgow, 1797.—Moresch, *De utero gravido*, Milan, 1817.—Maygrier, *Nouvelles demonstrations d'accouchemens*, Paris, 1822.—Mad. Boivin, *Mémorial de l'art des accouchemens*, Paris, 1821.

2nd. The most general condition necessary to produce it is the action of the normal seminal fluid of the male on the genital organs of the other sex, in a state of maturity, and when their vitality is exalted.

3rd. The most important of the special conditions is the necessity of a certain relation, a certain resemblance, between the male and the female organism.*

The first problem to resolve is the mode in which the semen of the male produces conception. On this subject there are two opinions:

1st. Some admit that the semen arrives at the ovary through the uterus and the Fallopian tube; that it causes directly the changes which occur in this organ, and even that its substance unites more or less in the uterus with the product of the ovary, to give rise to the new organism.

2nd. Others think that the semen does not act on the ovary directly, but only secondarily, by a change which it causes in the whole organism or in the genital organs, and does not contribute by its proper substance to form the new organism.

The principal facts in support of the first hypothesis are:

1st. The necessity of a channel for the semen, in order that the impregnation may occur, since it does not happen when the cavity of the female genital organs is interrupted.

2nd. The semen found in the uterus and the Fallopian tubes in females who died during or shortly after coition.

3rd. The necessity of copulation even to produce a new organism, for it is difficult to admit that impregnation may occur equally in any part of the body destitute of an epidermis, or at least covered by an epidermis as thin as that of the genital organs, as has been asserted.†

4th. The analogy of those animals in which the eggs are impregnated on leaving the body of the female by the semen of the male.

But these facts are not sufficient to demonstrate the exactness of the hypothesis they are adduced to support:

1st. In regard to the first argument, sterility may possibly depend on other causes, and besides it would follow only that the semen must necessarily act on a certain organ, as the uterus or vagina, in order that impregnation may occur.

2nd. Perhaps the fluid found in the uterus and Fallopian tubes was not semen, but was secreted by the female genital organs, and this is often found in the cavity of these two organs.

3rd. The third argument proves only that the semen must act on a certain organ.

4th. The fourth proves at most that the condition mentioned is rigorous in the animals to which it relates. Still it does not even demonstrate this, as the ova of these animals are surrounded by a thick layer of mucus.

* Wolstein, *Ueber das Paaren und Verpaaren der Menschen und Thiere*, Altona, 1815.

† Treviranus, *Biologie*, vol. iii. p. 407.

We may also adduce against this hypothesis and in the support of he second the following arguments:

1st. The experiments in which yellow bodies at least have been eveloped, although the Fallopian tubes had been carefully tied.*

2nd. In careful experiments on generation semen has seldom been ound in the uterus, and the consequences of conception are not aanifested till several days or weeks after coition.

3rd. In most animals the genital organs are so arranged, that on ccount of their length and tortuousness in the females, the marked rominences on the neck of the uterus, and the shortness of the male rgans, it seems almost impossible for the semen to arrive at the varies.

4th. The uniform sensation of pleasure and numerous general signs hich attend impregnation.

Hence it follows that the influence of the male is confined to exalt ae formative power in the female to the degree necessary to produce ie new being. This increase is manifested, as we shall soon state, y the direct formation in the ovary of a new organ, a *temporary sticle*, which secretes a fluid possessing the power of spontaneous rowth.

ARTICLE FIRST.

OF THE CHANGES IN THE GENITAL ORGANS PRODUCED BY COITION AND CONCEPTION.†

ORGANS OF COITION.

§ 2557. Coition usually changes the external genital organs very uch ; the hymen is generally more or less perfectly destroyed. Its emains give rise to the *carunculæ myrtiformes*, which term applies to ree or four small eminences, most generally triangular, which are tuated on the sides and posterior parts of the vagina. The existence f the hymen is not, however, a certain mark of physical virginity: rst, because this membrane has frequently been found, not only in males who had several times had connection, ‡ but also in others ho had given birth to fœtuses more or less advanced, and fœtuses

* J. Haighton, in the *Phil. trans.*, 1797.

† S. Pineau, *De virginitatis notis, graviditate et partu*, Leyden, 1654.

‡ Osiander (*loc. cit.*, p. 21.) mentions several cases of it.

even seven months old; * and second, because it may have been destroyed from other causes, and even may not exist from a primitive deviation of formation.

The enlargement of the vagina and the disappearance of its corrugations are still less constant and sensible.

II. FORMATIVE ORGANS.†

A. OVARIES.

§ 2558. The internal organs of generation are modified not by coition, but only by conception.

A special body, termed the *yellow* or *glandular body* (*corpus luteum s. glandulosum*), ‡ is developed in the ovary. It is a rounded, soft, very vascular tissue, composed of several lobes; it projects above the surface of the ovary, becomes about as large as a cherry, and incloses a cavity which opens externally. The number of the yellow bodies usually corresponds to that of the new organisms which have been formed.

From experiments on animals, these bodies arise from the change of one and not probably of several of the vesicles of Graaf, which, from being a simple serous membrane, is changed into a glandular organ, that is, its organism becomes more complex, and it acquires the faculty of producing a liquid different from the serum of the vesicles. As the yellow body differs in its structure from all the other glands, the fluid it secretes has also peculiar characters : it is the generating fluid, the semen of the female.

The influence of the male semen is the usual and regular cause of this change, which however seems to occur also from the effect of other stimuli, perhaps of the imagination or unnatural indulgences. In fact several rare cases, where yellow bodies have been found in unmarried females and virgins, and always attended with the phenomena mentioned above, lead us to think that the formation of these bodies had been preceded by the act of coition, and by impregnation. However as they have been found in animals generally sterile, as mules, our opinion as concerns females is very probable ; but we are not authorized by facts to think that the change of the vesicles of

* Tolberg, *De var. hym.*, p. 14.—We have in our cabinet the anatomical specimen, which is very remarkable.

† M. Malpighi, *De cornuum vegetatione, utero, viviparum ovis* ; in the *Opp. omn.*, Leyden, 1687, vol. i. p. 211.—A. Bertrandi, *Observations sur les corps glanduleux, sur la matrice et sur l'ovaire dans l'état de grossesse* ; in the *Miscell. Taur*, vol. i. 1758.

‡ Brugnone, *De ovariis corumque corpore luteo observationes anatomicæ* ; in the *Mem. de Turin*, 1790.—Roose, *Ueber die gelben Körper und Eierstrohe*, Brunswick, 1800.

Graaf into yellow bodies can be produced except by an unusual increase in the propensity to generation.*

Some have mentioned yellow bodies found in newly born or very oung animals; but it is easy to reply to this objection that every yelow substance found in the ovary is not a yellow body. Nor is the rgument drawn from the fact that the number of the yellow bodies oes not always correspond to that of the offspring, conclusive. If the umber of yellow bodies be fewer than that of the offspring produced y the female, this circumstance agrees with their signification, since ne yellow body as well as one testicle may produce several new organisms. Farther one or more of these bodies also might disappear r several be blended together. In the case where they were more umerous than that of the offspring; 1st, it is necessary to mention xactly if these which were supernumerary did not arise from anterior onceptions; 2nd, it would be possible, even in admitting that the anial has never conceived previously, that generation has not proceeded eyond the production of a yellow body, or that its production was ost. Besides we are very much disposed to consider as very uncerain, observations in the cases where it is pretended that the number f yellow bodies and that of the offspring differed, for the examination f more than two hundred women, and females of different mammaia in the state of pregnancy, has convinced me, that *the number of ellow bodies which from the absolute identity of all their characters ay be considered as produced by the same generating act, always coresponds to that of the young.* Observers known for their correctness ave come to the same conclusion,† while contrary assertions do not appear to be well supported.

The cavity of the yellow body is gradually obliterated; the body tself diminishes, collapses, and hardens. These changes do not appen exactly at the same period, and we have remarked generally n the human species or in animals, at least in respect to the size of e body, they are not very large during pregnancy, while after parurition they evidently increase more rapidly. This phenomenon is orthy of notice, as it teaches us that although the function of the ellow body and the ovary generally has passed at this period, vitality owever continues to be more active in them on account of the great egree of vitality in the uterus. Farther the yellow body rarely disppears entirely, although it diminishes extremely.

Haller ‡ and several others since his time have attributed the disovery of the yellow bodies to Volcher Coiter; § but it really belongs o Fallopius,|| who mentioned these bodies twelve years before Coiter,

* Joerg, *Von der Zengung*, p. 151.

† Haller, *El phys.*, vol. viii. pt. ii. p. 29-38.—Hunter, *Anatomische Beschreiung des menschlichen schwangern Uterus*, Weimar, 1802, p. 90.

‡ *El phys.*, vol. viii. p. 38.

§ *Obs. anat.* 1573, p. 121. *Vesiculæ quædam continebant aquam limpidam, uædam luteum humorum.*

|| *Obs. anat.*, Venice, 1561. *Vidi quidem in iisdem (ovariis) quasdam veluti*

and nearly in the same language. Malphighi * and Graaf † discovered their uses.

§ 2559. According to Osiander ‡ the vesicles of Graaf and the yellow bodies have no connection with generation, because the former have no openings. He asserts that after coition the parts which are changed into new organisms are developed on the surface of the ovary in the form of miliary vesicles, one of which is detached and falls into the uterus. He adds that we must consider these corpuscles as ova: 1st, because they never appear before impregnation; 2nd, because they are always observed after coition followed by impregnation; 3rd, because many are found in the cadavers of young females dying after a few pregnancies; 4th, because many are turgescent, others empty, and finally others resemble simple cicatrices; 5th, because they disappear entirely when the female is sterile.

These reasons do not seem satisfactory to us. The vesicles mentioned may be developed after copulation and disappear during life, although there were in fact no ova, since coition, when followed by conception, produces as great and to a certain extent even analogous changes in remote parts and in the whole organism.

Besides we have frequently found the ovaries of females, physically and morally virgins, covered with a dense miliary eruption, and in them the vesicles were too numerous to admit Osiander's opinion in respect to them.

Finally we may allege against this hypothesis the exact history of the changes in the vesicles of Graaf after impregnation.

The only argument adduced by Osiander to reject the use attributed to the vesicles of Graaf has no weight except against an unimportant opinion, that the vesicle itself is detached, and that the yellow body grows in its place; but this has no weight at all when, as seems to us more correct, we consider the yellow body a vesicle changed, which, according to all observations, is provided on the surface of the ovary with an opening communicating with its cavity, and through which the formative fluid may escape.

B. FALLOPIAN TUBES.

§ 2560. The only change produced by coition in the Fallopian tubes is this; soon after this act they are applied to the ovaries, so as to embrace a greater or less portion with their fimbriated extremity,

vesicas aqua vel humore aqueo, alias luteo, alias vero limpido, turgentes; in the *Opp. omn.*, Venice, 1606, p. 106.

* *Loc. cit.*, p. 223.

† *Loc. cit.*, p. 331.

‡ *Handbuch der Entbindungskunst*, Gottingen, 1802, vol. i. p. 129-145.

d to receive the fluid poured out by the yellow body, which they en carry into the uterus.

Their approximation to the ovaries is favoured by the portion of all intestine situated in the lower pelvis; for this portion tenses e ligaments of the ovaries and the broad ligaments of the uterus, is fixes the glands in their position, and applies the tubes to their rface, so that they extend a little on the outside of them.*

C. UTERUS.

§ 2561. The structure of the uterus † undergoes remarkable anges in many respects, and the new organism is developed within

Even before we perceive any trace of the new being, we already d the uterus a little enlarged at its upper part, its substance is ter, looser, more lamellar, its component layers are more distinct, vessels are dilated, its inner face is smooth but irregular, extremely scular, and also covered with numerous very minute flocculæ, which nnot be seen except with a microscope, and finally it is covered with ultaceous matter into which the vessels extend, and which passes on neck of the organ, so as to close the cavity of the body. This stance resembles coagulated blood. It is thickest at its upper t, where it is connected with the uterus more intimately than in other place. Below it is very thin and united to the organ more sely, and even does not adhere to it at all.‡

The vaginal orifice and the neck are also filled with a viscous, ning substance, similar to gelatine.

These changes increase uninterruptedly until the end of pregnancy, ich generally continues ten lunar months.

The fibrous texture becomes more and more distinct: it cannot well perceived § except during pregnancy or in analogous states of the rus, when this organ also enlarges, as for instance, when abnormal nations are developed within it. It is then certain that if the es do not form during pregnancy they are at least developed and y much enlarged at that time.

Autenrieth, *Ueber die eigentliche Lage der innern weiblichen Geschlecht-ile*; in Reil, *Archiv. für die Physiologie*, vol. vii. p. 294.

Beside the works already mentioned in respect to the uterus, consult also: Vater, *De utero gravido*, Wittemberg, 1725.—Beyer, *Utrum in gravidis totus us æqualiter extendatur*, Paris, 1729.—P. A. Boehmer, *Situs uteri gravidi usque, ac sedes in utero*, Halle, 1748.—B. S. Albinus, *Tabulæ uteri gravidi*, den, 1748.—Id., *De utero gravido nonnulla*; in the *Annot. acad*, l. ii. cap. v. . Weitbrecht, *De utero muliebri (gravido) observationes anatomicæ*; in *N. C. rop*, vol. i. p. 337.

The case of a young woman who poisoned herself in the first month of her gnancy, by Th. Ogle; to which is added an account of the appearances after th, by J. Hunter; in the *London med. trans. for the improvement of med. chir. knowledge*, vol. ii. p. 63.

This remark has been made already by Vesalius (*De corp. hum. fab.*, book v. v.), and by Santorini after him (*Observ. anat.* c. x-i, § 13).

Hence why the uterus, although it enlarges and becomes much softer, is not only distended but enlarges considerably.

Some days after parturition occurs, when the term of pregnancy has been normal, the uterus weighs at least twenty-four ounces, as we have proved by examining twelve cadavers of females dying at this period ; so that even then, although the organ had already collapsed, its weight was to that of the uterus in a virgin as 24 : 1.

Another question now presents itself, viz. do the parieties of the uterus, which, from the preceding remarks, are not only distended, but also become thicker, remain the same, or do they grow thinner ? The latter perhaps is true, notwithstanding the increase in the mass and weight, on account of the considerable extension of the uterus during pregnancy.

This problem has been resolved several ways.*

Those who admit that the parietes of the uterus preserve the same thickness, or even become thicker, explain the contrary assertion by saying that the thickness of the uterus, considered generally, varies in the state of pregnancy,† and that an uterus, when filled with the product of conception, has not the same thickness in every part.‡ We may also say that sometimes the uterus, from a pathological state, is not properly developed, and is only distended, which perhaps is one of the causes which contribute to render parturition painful.

Our observations made upon sixteen uturi at all periods of gestation, leads us to think that very probably the parietes become a little but not much thicker at first, and that towards the end of pregnancy they gradually become much thinner.

In fact we have found the parietes of the uterus six lines thick, three weeks after conception; five, at the beginning of the third month ; four, at the commencement of the fourth ; at the end of this month, four in two cases ; three at the upper part, and four at the lower in a third, and five in a fourth case ; at five months, three lines thick in one case, two at the upper part, and four in the lower in another ; at six and seven months, a little less than three ; at eight months, from two to two and a half lines in one case, and in another, three lines at the upper part, and more than four at the lower : they have appeared to us a little thinner at nine months.

On the contrary the uterus when collapsed after parturition is generally an inch thick at the end of seven, eight, and nine months.

The veins and the arteries of this organ are extremely dilated, so that the venous trunks are as large as the axillary veins. These two orders of vessels become less tortuous as the uterus enlarges.

* Haller has collected most of the opinions on this subject (*El. phys.*, vol. viii. p. 2. p. 58).
† For instance, F. A. Walter, *De polypis*; in the *Annot. Ac. Berol.*, 1785, p. 3.
‡ Hunter, *loc. cit.*, p. 21.

The dilated veins of the uterus have very improperly been termed *sinuses*.

The place where the blood-vesels are most developed is where the new organism unites directly with that of the mother, that is, at the insertion of the placenta.

§ 2562. The form of the uterus is also considerably changed. As the body only of the organ is developed during most of pregnancy, the disproportion between it and the neck always becomes greater, and even, as when the neck is finally distended, in the latter periods of pregnancy it shortens in proportion as it enlarges, the disproportion only becomes still more perceptible, so that the uterus is rather oval than pyriform, especially near parturition.

This organ also becomes considerably thicker from before backward in proportion to its breadth than it was before, although it still continues to be a little more broad than thick.

The orifice of the vagina begins to become round at the first month.

§ 2563. Great changes supervene also in the situation of the uterus.

During the first two months of pregnancy the uterus gradually descends a little in the pelvis, so that its orifice is more easily perceived with the finger introduced into the vagina; but at three months it begins to reascend, and also changes its direction, its base goes farther forward, and its orifice backward. These changes increase so much, as pregnancy advances, that it becomes more and more difficult to reach the os tincæ, and more so as the lower part of the anterior wall of the uterus is crowded from above downward, before it, by the lower part, the head of the child. In most cases, in proportion as the uterus is developed, its base rises, and becomes evident through the distended integuments of the abdomen.

The anterior face of the organ, especially in the latter months of pregnancy, is situated directly behind the anterior wall of the abdominal cavity. It pushes the small intestine upward, backward, and on the sides; at least this intestine very rarely descends between the uterus and the anterior wall of the abdomen,* and this case probably never happens at the end of gestation.

§ 2564. After parturition the uterus contracts, and in a few days its parietes are more than an inch thick.†

Its volume returns gradually, and even during the first few weeks, to the size it had before pregnancy; its vessels contract, and at the same time its loose and lamellar structure disappears. It however always remains larger and softer than in a female who has never borne children. It begins to diminish much and to become harder only at an advanced age.

The orifice of the vagina, which in the latter period of preganancy had become a rounded opening, resumes its ancient form: but it is

* D. Monro, in the *Edinb. Essays, an. ob.*, vol. i. p. 456. At the sixth month of pregnancy.

† Hunter, *loc. cit.*

generally torn more or less deeply, whence it is uneven and corrugated. The lips, particularly the posterior, are thicker and longer. They are adapted to each other less exactly.

ARTICLE SECOND.

DEVELOPMENT OF THE NEW ORGANISM.*

§ 2565. The first origin of the new organism is very obscure. We do not know whether the fluid secreted in the yellow body directly assumes any form, so that the ovary furnishes a vesicle filled with liquid, which is the first trace of the *ovum* or of the *envelops* (*involucra, s. membraneæ*) of the fœtus: or if this change takes place only in the tube, perhaps even in the uterus.

The possibility of the development of the new organism in the ovary does not prove that the fluid of the vesicles is changed there in the normal state; we ought only to conclude that when this fluid does not arrive in the uterus it may assume in every other part the form of an ovum.

It is very doubtful† whether the ova, discovered in the Fallopian tubes,‡ of animals, were really what they were supposed to be, and more so because other observations render another mode of development probable, and particularly that the ovum takes its form in the uterus.§

But there is a rounded vesicle, composed of several membranes adapted to one another, and containing different fluids, constantly formed before the fœtus. The fœtus is developed within the ovum, which connects it with the organism of the mother. As the human ovum is generally ruptured at its lower part at the period of parturition, and the infant is delivered before it, it is termed the *secundines* (*secundæ, s. secundina*).

* Beside the works cited above, which treat also of the changes in the genital organs, consult: T. Kerkring, *Anthropogenia*, Amsterdam, 1670.—M. Schurig, *Embryologia*, Dresden, 1732.—F. G. Danz, *Grundriss der Zergliederungskunde des ungebornen Kindes*, Frankfort, 1792-1793.—C. F. Burdach, *De primis momentis formationis fœtus*, Konigsberg, 1814.—O. C. Lucæ, *Grundriss der Entwicklungsgeschichte des menschlichen, Körpers*, Marburg, 1819.—Beclard, *Embryologie, ou Essai anatomique sur le fœtus humain*, Paris, 1820.

† Hartmaan, *Dubia de generatione viviparorum ex ovo*, Konigsberg, 1699, § 14.

‡ De Graaf, *De mulierum organis*, cap. xvi.—G. Cruikshank, in the *Phil. trans.* 1797.

§ J. C. Kuhlemann, *Observationes circa generationis negotium in ovibus factæ*, Gottingen, 1753.—Haller, *De quadrupedum utero, conceptu et fœtu*; in the *Opp. min.*, vol. ii. p. 32.

I. ENVELOPS OF THE FŒTUS.

§ 2566. The membranes of the ovum* are much larger and heavier the farther the fœtus is from the period of its formation. Taken with the fluid they contain, they are at first much heavier than the fœtus, and they even weigh more than it at the end of the third month, after being emptied, although the disproportion is then less, as may easily be conceived. At the end of the third month, that is, after about the first third of fœtal existence, their weight is nearly equal. After this period an inverse relation exists, so that the mean weight of the membranes of the ovum is to that of the fœtus as 1 : 8, since a well grown fœtus weighs about eight pounds, and the weight of the secundines, including that of the cord, weighs rather more than one pound.

The first trace of the fœtus is the substance which fills the uterus soon after coition, and which seems to be only coagulated blood.

This substance forms the most external membrane of the ovum, the *deciduous* membrane.

A. DECIDUOUS MEMBRANE.

§ 2567. The *deciduous* membrane, *épichorion*, Ch. (*M. decidua*, s. *caduca*, *tunica ovi exterior*, *membrana Hunteri*)† which surrounds

* Beside the works already mentioned, particularly those of Nortwyck, Sandyfort, and Hunter, consult: A. Vater, *Mus. anat. propr.*, tab. viii. Wittemberg, 1701.—Ruysch, *Thes. anat.*, *VI.* tab. i. and ii.—G. Vater, *Mola prægnans*, with a plate.—O. Borrich, *Abortus humanus examinatus*; in the *Act. Hafn.*. vol. ii. p. 49.—B. S. Albinus, *De vasis placentæ parvulorum embryonum et de involucro, quo edita eorum ova continentur*; in the *Annot. acad.*, lib. i-xvii.—Id., *Nonnulla de embryonibus humanis ovisque; quibus continentur*, ibid., xix.—P. A. Boehmer. *Instit. osteol.*, Halle, 1751, tab. i. f. 7, 8.—D. C. Burdach, *De læsione partium fœtus nutritioni inservientium abortus causa*, Leipsic, 1768.—E. Sandifort, *De ovo humano, absque ullo fœtus indicio, et placentæ in hydatides*; in the *Obs. anat. path.*, book ii-lii. p. 76.—Id., *De ovo humano*, ibid., book iii-vi. p. 91.—Blumenbach, *Institutiones phys.*, 1787, tab. iv.—S. T. Sœmmerring. *Icones embryonum humanorum*, Frankfort, 1799.—Denman, *Practice of midwifery*, London, 1801, tab. vi-viii.—Wrisberg, *Obs. anat. obst. de structura ovi et secundinarum humanarum in partu naturali et perfecto, collectæ*, Gottingen. 1782.—C. G. Krummacher, *Diss. sistens observationes quasd. anat. circa velamenta ovi humani*, Duisburg, 1790.—J. F. Lobstein, *Essai sur la nutrition du fœtus*, Strasburg, 1802.—Samuel, *De ovarum mammalium velamentis*, Wurzburg, 1816.—Dutrochet, *Recherches sur les enveloppes du fœtus*; in the *Mém. de la soc. méd. d'émul.*, vol. viii., 1817, p. 1-60.—G. Cuvier, in the *Mém. du Museum*, vol. iii.—Dutrochet, *Observ. sur la structure de l'œuf des mammifères et examen de la doctrine de Cuvier sur cette matière*; ibid., p. 760-767.—Dutrochet, *Mém. sur les enveloppes du fœtus*; in the *Journ. compl. du Dict. des sc. méd.*, vol. v. p. 241.—Velpeau, *sur les membranes du fœtus*; in the *Archiv. gén. de méd.*, November and December, 1824.

† Haller, *Elem. phys.*, vol. viii. p. 183.—Osiander, *Handbuch der Entbindungskunde*, pt. i. p. 191.—F. J. Moreau, *Essai sur la disposition de la membrane caduque, sa structure et ses usages*, Paris, 1814.

the envelops of the ovum belonging to the fœtus is attached by its inner face to the chorion, and by its external face to the inner face of the uterus.

It is entirely different from the other membranes, is thicker, more opaque, but infinitely less solid. It has about the consistence of coagulated fibrine, which it also resembles in its yellowish colour.

Its thickness is not the same in all parts of its extent. It is generally thicker in the region of the placenta, and smaller at the lower part, opposite the internal orifice of the uterus, than in any other point.

It always diminishes from the moment of its origin, so that finally it is scarcely half a line thick. Its external face is at first uneven and corrugated; but in time it becomes smoother, as is already its internal face. The connections which unite it to the uterus are much looser in the early periods than at the end of pregnancy.

It presents in a greater or less portion of its extent more or less evident perforations, which give it a reticulated or cribriform appearance.

It receives a great number of vessels, which are prolongations of those of the uterus, and which descend obliquely into it.

§ 2568. The deciduous membrane not only surrounds the ovum: it forms a double layer around it, and it is consequently arranged like the serous membranes.

In fact, beside the portion of this membrane which unites it by its external face to the internal face of the uterus, there is a second which is reflected on the preceding, and is contained within it.

This second layer is attached by its inner face to the chorion, and is loose on its external face, while the other fold is loose on its internal face, and adheres to the uterus by the external.

The first fold of the membrane is called the *external* or *true deciduous* membrane (*M. decidua externa*, s. *vera*): the other is termed the *internal* or *reflected deciduous* membrane (*M. decidua interna*, s. *reflexa*); it has also very improperly been termed the *fungous deciduous* membrane (*chorium fungosum*).

The arrangement of the deciduous membrane however differs from that of the serous membranes, because the external fold is not only reflected npon the chorion, but also on leaving this point, where it is inflected, it is extended on the latter, which it consequently envelops in every part.*

* Moreau (*loc. cit.*, p. 16) does not assent to this opinion. When the ovum is separated from the uterus it seems in fact enveloped in every part by the deciduous membrane: but according to him, as the flocculent tissue which covers the placenta at the third or fourth month of pregnancy does not exist in the first, and as from the fifth to the seventh month it is changed into a real cellular tissue, to form the uterine portion of the placenta, into which the vessels of the fœtus open with the uterine veins, we must consider it a tissue of secondary formation, similar to the deciduous membrane, with which it is continuous, and not as a part of appendage of this membrane. F. T.

The reflected deciduous membrane particularly is thin and reticulated, and it is much thinner than the chorion. It likewise becomes much thinner as the ovum enlarges. It also approaches the external deciduous membrane, to which it is finally more or less adherent.

§ 2569. The external deciduous membrane never extends beyond the internal orifice of the uterus. On leaving this point the uterus or the neck is filled only with a gelationous fluid.

According to some observers the external deciduous membrane extends to a certain extent in the tubes, especially on the side where the yellow body is formed,* and it is open at the place of the uterine orifices of the tubes, as also at its lower part, that which passes on the inner orifice of the uterus.† Perhaps these openings exist at first, but the membrane seems to change very soon into a perfectly closed sac, since the lower opening does not exist during the first month,‡ and the upper two are also effaced at the second.§

§ 2570. It is not very easy to explain how the reflected deciduous membrane is formed. Most probably the ovum, or the fluid from which it is produced, penetrates into the substance of the deciduous membrane, which is always very soft and very loose, but which presents these characters primitively, the spaces resulting from them afterwards close, and the ovum is then developed in the cavity of the membrane.‖

This theory agrees with the observations from which it has been concluded that the external and internal deciduous membranes are primitively distinct, that the external appears first, on leaving the base of the uterus, as a membrane possessing longitudinal blood-vessels, and consequently composed apparently of bands which have the same direction, and that the internal is developed afterward, on leaving the inner face of the preceding, and possesses horizontal vessels: so that the ovum on arriving at the uterus falls into a cavity, the roof and parietes of which are formed by the external deciduous membrane, while the floor is constituted by the reflected deciduous membrane.¶

At least it follows from these same observations that the ovum is not introduced into the substance of the deciduous membrane at the

* J. Hunter, in the *Trans. for the improv.*, vol. ii. p. 67.

† G. Hunter, *loc. cit.*, p. 77.

‡ J. Hunter, *loc. cit.*, p. 67.

§ Lobstein, *Sur la nutrition du fœtus*, p. 4.

‖ Moreau asserts that when the ovule enters the uterus through the Fallopian tube, it only pushes before it the deciduous membrane, which is already a little organized before its arrival; that it is covered, as is every internal viscus, by the serous membrane of the sphlancnic cavity in which it is situated; that this keeps it in contact with that portion of the uterus to which it is attached; that it is reflected on it leaving the place where the placenta is formed, and which is the only part not covered by it; that the three openings admitted by Hunter do not exist: in a word, that the deciduous membrane is arranged exactly like the serous membranes. This theory is more probable than the ancient, and has been developed by Velpeau, who supports it by the observation and dissection of a dozen human ova. F. T.

¶ Burns, *Observations on the formation and structure of the human ovum*; in the *Edinb. med. and surg. Journal*, vol. ii. p. 1-4.

same period as when this membrane is developed on the inner face of the uterus,* since the phenomena mentioned by us have been observed in the cases where the ova are still contained in the tubes.†

§ 2571. Notwithstanding its early appearance, the deciduous membrane does not belong to the fœtus, and is not indispensable for its development, since it also forms equally in the uterus in cases of extrauterine fœtation, and the fœtus then is not the less developed, although destitute of it.‡

B. MEMBRANES OF THE FŒTUS.

§ 2572. The ovum, on the contrary, includes other parts which are essentially connected with the formation of the fœtus. These parts are the *chorion*, the *amnios*, the *umbilical vecicle*, and the *allantoid membrane*, which we proceed to describe, without regard to the order in which they form, nor the part they take in the special vitality of the fœtus.

I. CHORION.

§ 2573. The *chorion* (*chorion*, s *chorion pellucidum*, s. *M. vasculosa*, s. *extima*), the most external of the special membranes of the ovum, is thin, transparent, and villous on its two faces, particularly the external. The villosities of this latter are much longer than those of the internal and ramify.

The external villosities are masses of vessels, the trunks of which unite to form the umbilical vessels.

These vessels are at first single, but more or less prominent at intervals like varices, and are composed only of veins.§

Notwithstanding its thinness and transparency, the chorion is formed of two layers, an internal and an external, between which wind small vascular trunks communicating with the villosities, and which arise from them.‖

* Hunter, *loc. cit.*, p. 81.
† Burns, *loc. cit.*, p. 3.
‡ Chaussier, in the *Bull. de la fac. de Paris*, 1814, no. 6, vol. iv. p. 137.
§ Lobstein, *loc. cit.*, p. 65.
‖ This opinion, admitted by Howson, Bojanus, and Dutrochet, is rejected by Velpeau. He thinks that the chorion is always formed by a single layer, and if it is considered to be formed by two, it is only because rather a thick membranous concretion forms between it and the placenta when this latter is developed, which may be separated into several layers. As the placenta is developed on the outside of the chorion, the same anatomist also states that it covers the fœtal face of this organ, and is even reflected on the cord, with which it arrives at the umbilicus, where it blends with the skin of the fœtus. F. T.

Its external face is united with the internal face of the deciduous membrane, and by the internal with the amnios.

Although there may be on its external face only a great developent of vessels, we cannot, however, demonstrate the existence of hese latter in its substance. In fact many observers have admitted hem, and even very recently it has been adduced in favour of their xistence that the deciduous membrane contains so many of them, ecause, they say, these last must penetrate into the chorion; and ie vessels of the deciduous membrane seem to us to have with those the chorion a relation similar to that between the vessels of the terine portion and those of the fœtal portion of the placenta, and in is hypothesis we can easily conceive of the great vascularity of the eciduous membrane.

The chorion has no lymphatic vessels or nerves.

§ 2574. Its form and connections vary much at different periods of ie life of the fœtus. It is proportionally much thicker at first than is subsequently: it is thicker than even the amnios, but gradually ecomes thinner.

At this period also its structure and thickness are uniform in every art.

Its external face is villous in every part, and these villosities are first longer than they are afterward and in the second month are rtuous and proportionally longer than before. But after the third onth these villosities gradually disappear in most of its extent, ually from below upward, so that the outer face of the membrane finally almost smooth, and the portion which surrounds the inseron of the umbilical cord is the only one where we still observe the llosities compactly arranged, and uniting to form the cord.

This place forms with the deciduous membrane a rounded mass, iich in the full-grown fœtus occupies about the third of the cirmference of the ovum, and is termed the *placenta*.

The chorion, which forms its inner face, is much thicker there an in other parts.

At first this membrane is united to the deciduous membrane more osely than it is subsequently; but it is gradually attached to it so timately that they are separated with difficulty, particularly on the rcumference of the placenta, where the union occurs by numerous aments, remnants of vascular villosities, with which its whole surce is at first covered.

II. AMNIOS.

§ 2575. The *amnios* (*amnion*, s. *tunica ovi intima*) is a very thin d transparent membrane, which directly envelops the fœtus. Its ternal face adheres but feebly to the chorion, except where it covers

the inner face of the placenta: the internal, on the contrary, is loose. These two faces are perfectly smooth, excepting always some very loose cellular tissue which covers the external.

Often and perhaps even always during the early periods of pregnancy, this membrane is more or less separated from the chorion, which is much more extensive, and between them is a fluid termed the *false waters of the amnios* (*liquor amnii spurius*). But this liquid disappears early, at the second month,* when the two membranes touch, although they are sometimes separated at the fourth and fifth months.†

The amnios is reflected on itself at the origin of the umbilical cord, covers the umbilical vessels, of which it forms the external envelope on the sheath, and extends to the anterior face of the abdomen, where it is continuous with the projecting portion of the skin of this region which forms the umbilicus.

As yet neither blood-vessels nor nerves have been found in the amnion, although very probably the substance which serves to unite it with the chorion contains the passages through which the nutritious and secretory fluid penetrates to it.

§ 2576. This membrane contains a liquid termed the *waters of the amnios* (*liquor amnii*,)‡ which varies in several respects at different periods of the life of the fœtus.

In regard to its physical qualities it is limpid and more or less transparent in the early periods of pregnancy; but at the end it becomes turbid and more or less flocculent. It is also at first thinner and less viscous.

It has a strong odour, analogous to semen. Its taste is slightly saltish.

It contains a considerable number of globules.

Its specific gravity is a little less than that of water.

Its absolute and relative quantities vary at different periods of pregnancy. The nearer the fœtus is to the period of formation, the more abundant proportionally the waters of the amnios.

* Hunter, p. 67.

† Lobstein, p. 23—24.

‡ Franck, *De liquore amnii*, Gottingen, 1764.—F. A. Kœnig, *De aquis ex utero gravidarum et parturientium profluentibus*, Halle, 1769.—J. P. Hettler, *De liquoris amnii naturâ ac indole*, Giessen, 1776.—H. Van den Bosch, *De naturâ et utilitate liquoris amnii*, Utrecht, 1792.—P. Scheel, *Diss. de liquoris amnii arteriæ asperiæ fœtuum humanorum naturâ et usu, cui adjectus est appendix sistens generaliora quædam de liquore amnii*, Copenhagen, 1799.—Buniva and Vauquelin, *Expériences sur les eaux de l'amnios*; in the *Ann. de chimie*, vol. xxviii., and *Mém. de la soc. méd. d'ém.*, vol. iii. p. 229.—F. F. Reuss and F. A. Emmert, *Chemische Untersuchung des Fruchtwassers aus dem zeitigen Ei und der käsigen Materie auf der Haut der neugebornen Kinder*: in Osiander, *Annalen*, Gottingen, 1801, vol. ii. p. 107.—G. Egeling, *De liquore amnii, nec non positiones medici argumenti*, Leyden, 1813.—G. F. Fuckel, *De liquoris amnii in fœtus corporis superficiem pressione*, Marburg, 1819.

About the middle of gestation their weight nearly equals that of ne fœtus.

From this period they gradually diminish, so that even when the etus is delivered without breaking the membranes, they do not eigh more than a pound, and in common parturition not more than ght ounces.

Their absolute like their relative quantity increases at first, but terwards diminishes. Thus, for instance, we find only thirty-six nces from the third to the fourth month.

In regard to chemical composition it is to be regretted that the iters of the amnios in the female have not yet been analyzed, nor mparative experiments made, which however are not difficult, in imals at different periods of gestation. All those we possess were ade on the waters received at the moment of parturition, that is, in e latter periods of pregnancy.

According to Scheel the waters of the amnios contain free oxygen; t the analyses of it made since* have not confirmed this asseron.† We find in it no traces of loose alkali.

The fluid portion is composed of a considerable quantity of water, ittle albumen, a still smaller proportion of gelatine, of the hydrolorates of ammonia and soda, and of phosphate of lime. Heat, ohol, and acids do not change it, or but very slightly.

The flocculæ are very similar to the mucus of the mucous memanes.‡

Some think that the waters of the amnios are formed by the fœtus l others by the mother. The first represent it as an excretion, l the second as a nutritious substance.

Among the first some think it comes from the urine of the fœtus, l others that it is exhaled by the skin.

Many§ suppose that its composition is mixed, especially in the ter periods of pregnancy, that it is formed partly of the excretion the fœtus, partly also by a nutritious substance.

The most probable opinion is, that the waters of the amnios are reted at least in great part by the vessels of the mother, although he end of pregnancy they are furnished partly by the fœtus. We e been led to this opinion because it seems infinitely probable t this liquid serves for the nutrition of the fœtus. In fact:

st. As it seems to contain more nutritious substance than during first periods, because more coagulum is produced by heat and

Lassaigne (*Sur l'existence d'un gaz respirable dans les eaux de l'amnios*; in *Archiv. gén. de Méd.*, vol. ii. p. 308.) has found in the amniotic fluid of the 1.130ths. of a gas similar to the atmospheric air, as it was composed of azote , and of oxygen 21.7. F. T.

Van Doeveren, *Obs. acad.*, c. vii. p. 103.

Emmert, *loc. cit.*, p. 116.

Emmert, p. 121.

alcohol,* we can explain this difference by admitting that the nutritious substance has been absorbed at first, and that when it is less abundant it has been replaced by another mode of nutrition.

2nd. The waters of the amnios are probably absorbed by the skin; for after tying a ligature around the limbs of a fœtus plunged into this liquid, the sub-cutaneous lymphatics soon swelled, while those of the limbs which were not tied were empty.† Secondly, fœtuses have been born with the mouth closed, and with an umbilical cord entirely separated from the placenta, closed and rounded at its loose extremity.‡

3rd. The amniotic fluid also penetrates through the mouth, since it has been found in the stomach, esophagus, cavity of the tympanum, and trachea, where it has been easily recognized both by its physical properties,§ as by the silky hairs of the child, and also the meconium.||

4th. Correct observations teach us that the fœtus inspires and swallows, by which the waters of the amnios penetrate into the digestive and air passages.¶

5th. Animals newly born have been nourished for several weeks by keeping them in the waters of the amnios.**

But besides these uses relative to nutrition, the waters of the amnios fulfil other functions which contribute directly or indirectly to preserve the fœtus:

1st. They preserve it from all commotion and compression.

2nd. They keep up the normal distention of the womb.

3rd. They connect the ovum and the uterus most intimately.

4th. They moderate the pressure of the fœtus on the uterus.

But they do not serve, as has been said, to prevent the obliteration of the openings and the cavities of the body:†† first, because we not unfrequently find such anomalies; second, because the mucous membranes have no tendency to adhere, at least unless alterations in texture supervene in them. The observations of abnormal anuses, which continued open for many years, proves also that these secrete fluids enough to prevent the union of their surfaces.

The waters of the amnios are useful also in parturition, because they dilate the orifice of the uterus, and lubricate the external organs of generation.

* Osiander, *Annalen*, vol. i. pt. i. p. 190–200.—Lobstein, *loc. cit.*, p. 103. We have always observed this in the fœtuses of the ewe.

† Brugmans, in Van den Bosch, *loc. cit.*, p. 466, 467.

‡ Ibid.

§ Winslow, Herholdt, Rafn, Abildgaard, Scheel; in Scheel, *loc. cit.*, p. 12.

|| Osiander, *Handbuch der Entbindungskunde*, vol. i. p. 237.

¶ Winslow, in Scheel, *loc. cit.*, p. 12.—Beclard, in the *Bull. de la fac. de Paris*, 1813, no. 6—8.

** Weydlich, in Pohl, *Embryochemia*, Erlangen, 1805, § 12.

†† Lucæ, in Fuckel, p. 10.

III. PLACENTA AND UMBILICAL CORD.

A. PLACENTA.

§ 2577. The *placenta** is generally a rounded, oblong, soft, but solid mass, particularly at its circumference, and is composed of the chorion and the deciduous membrane. It is the most vascular part of the ovum, that by which it is attached most intimately to the uterus.

This body is generally eight inches long in its greatest diameter, six in the smallest, and one thick; but it gradually becomes thinner towards the circumference. Its thickest portion is where the umbilical cord is detached from it. It is generally inserted, especially in the first pregnancy, at the upper and posterior part of the uterus, a little to the right. None of the mechanical explanations of this phenomenon are satisfactory.†

The placenta is composed of a considerable number of lobes (*cotyledones*), which vary in size, and are rounded and irregular in form; they are particularly apparent on its outer or uterine face, and render it very uneven.

About the period when the fœtus is full-grown, it is covered at its outer face by a layer very similar to the deciduous membrane, which extends not merely from one lobe to another, but penetrates between them and unites very intimately with the vessels of the placenta. These last communicate with those of the uterus. Between them and the placenta are very large veins. We remark particularly on the circumference of the placenta a circular vein, into which several veins of the deciduous membrane open.

Although this layer is similar in structure to the deciduous membrane, it seems however to form afterward, since the portion of this latter which corresponds to the placenta disappears soon after its union with the uterus, and the layer in question exists only during the latter half of pregnancy.‡

The inner face of the placenta is smooth and formed by the chorion, which is thicker there than in any other part, and the amnios covers also its inner face.

We remark in it the largest of the branches and trunks of the three umbilical vessels which unite the body of the fœtus with the membranes of the ovum.

The placenta grows constantly and absolutely after it is first formed; but it diminishes in proportion to the fœtus and the other

* G. Munniks van Cleef, *De usu placentæ humanæ comparatione ejusdem cum animalium placentis illustrato*, Utrecht, 1819.

† B. F. Osiander, *De causâ insertionis placentæ in uteri orificium ex novis circa generationem humanam observationibus et hypothesibus declaratâ*, Gottingen, 1792.

‡ Wrisberg, *Descript. ovi et secund.*, § 183. Lobstein, *loc. cit.*, p. 58.

parts of the ovum, since the vessels of the chorion are mostly and gradually obliterated. Even a part of those of the placenta gradually close, and then appear so many cords filled here and there with phosphate of lime, particularly towards the upper face of the organ. This deposit occurs also out of the vessels. It is a sign of maturity, of old age, of the mortification of placenta, and it is therefore observed only when the latter is about to be detached.

The maturity of the placenta is indicated by its receiving fewer vessels; it becomes dryer, and even diminishes in its mass and size,* although these changes are much less evident in the female than in the females of animals.† We must then consider them as a commencement of separation between the organism of the child and that of the mother, as a prelude to parturition.

B. UMBILICAL CORD.

§ 2578. The *umbilical cord* (*funiculus umbilicalis*) is composed at least of the following parts during all of fœtal existence.

1st. The umbilical vein and two arteries.

2nd. A soft, semi-fluid, and gelatinous substance, which surrounds these vessels, and is termed the *gelatine of Wharton* (*gelatina Whartoniana*).

3rd. The *urachus*.

4th. The *umbilical sheath* (*vagina umbilicalis*), which surrounds all these parts, and which proceeds from the amnios.

It also contains during the early periods, and particularly until the third month,

5th. A portion of the intestinal canal, which is much larger the younger the fœtus is.

6th. The whole or a part of the umbilical vesicles.

7th. The omphalo-mesenteric vessels.

Hence why it is then much larger than it is subsequently.

At first until the second month, sometimes even later than this, but then an anomaly exists, the umbilical vesicles are straight. They gradually become more or less tortuous, and the cord also assumes this appearance, the more so as its caliber also diminishes. It is curious that these inflexions generally take place in the same direction, from left to right, which occurs nine times to one, judging from our observations.

The gelatine of Wharton varies in quantity. Hence the difference between *fat* and *lean* cords.

* Lobstein, *loc. cit.*, p. 141, 142.
† Joerg, *Ueber die Zeugung*, p. 220.

We may inject this gelatinous substance* with mercury by com-
essing it a long time; but we cannot conclude certainly from this
at it receives special vessels for transmitting a fluid from the pla-
nta into the body of the fœtus. We can at most conclude from this
periment that the gelatine of Wharton is composed of tunnels
lapted one to another, formed by cellular tissue, and containing a
bstance in motion which probably serves to nourish the fœtus.†
lthough different ancient and modern anatomists assert they have
scovered some lymphatic vessels in the umbilical cord,‡ neither
obstein nor myself§ have perceived them, notwithstanding all our
searches on this subject.

The umbilical sheath envelops the parts which form the cord, but
ot tightly. It differs more from the skin of the fœtus the older the
tus is.

We have not been able to satisfy ourselves of the existence of nerves
the umbilical cord,‖ and we therefore do not admit them.¶

§ 2579. The umbilical cord does not generally arise from the cen-
e of the placenta, but is inserted a greater or less distance from its
lge. It is attached to the anterior face of the abdomen, as much
wer, the younger the fœtus is, and on leaving this part its consti-
ent portions separate.

It varies in size and length at different periods of fœtal existence.
At first and until the end of the first month it does not exist, and
e fœtus rests directly on the amnios.

When it once begins to appear, it extends continually until the
tus is matured, so that it is generally about two feet in length at
is time, and hence nearly as long as the full-grown fœtus.

We must however remark that these two periods are generally
parated by a third, during which the umbilical cord is propor-
onally longer, and exceeds more or less that of the fœtus; this
curs at least from the end of the second to the end of the sixth
onth.

At the end of pregnancy, however, the cord is from one to two
et long.

§ 2580. The placenta and the umbilical cord establish the commu-
cation between the child and the mother. The first is essentially
omposed of two different parts, the *fœtal* and the *uterine* portion.

* Uttini, *Sur les vaisseaux absorbans du placenta*; in the *Mem. dell' inst. naz.
il.*, vol. i.

† Lobstein, *loc. cit.*, p. 38

‡ Michaelis, *Observationes circa placentæ ac funiculi umbilicalis vasa absorben-
t*, Gottingen, 1790.

§ *Loc. cit.*, p. 84

‖ Chaussier and Ribes assert that they have followed the filaments of the gan-
ionnary nerves of the fœtus along the umbilical vessels into the placenta. (Chaus-
er, *Expériences nouvelles sur la digestion, et remarques à ce sujet*; in the *Journ.
niv. des sc. méd.*, vol. i, p. 233).

¶ E. F. Durr, *Diss. sistens funiculum umbilicalem nervis carere*, Tubingen,
15. J. S. Rieck, *Utrum funiculus umbilicalis nervis polleat, aut careat*, Tubin-
n, 1816.

The *fœtal* portion is formed by ramifications of the umbilical vessels and by the chorion; the *uterine* by the prolongations of the uterine vessels and by the deciduous membrane. These two portions are united much more intimately the older the fœtus is; but their respective vessels always remain separate, so that the arteries and veins of the uterine portion communicate directly, as do those of the fœtal placenta. Hence why injections of the uterine vessels, even when most successful, fill only the uterine placenta, while those through the umbilical vessels fill only the fœtal portion. Hence also when we inject the placenta detached from the body, or when it is not separated from the body of the living infant, so that the blood circulates uninterruptedly within it, there is no dribbling of blood from its loose surface. Hence the pulses of the mother and the umbilical cord are not isochronous.

This explains why children born without the rupture of their envelops can live a greater or less length of time, the circulation continuing perfectly,* and probably only the change of temperature obliges us to open all the envelops, although Wrisberg has prolonged the experiment for nine minutes, and Osiander for a quarter of an hour.

The same fact explains why the cord, which remains for a long time in communication with the mother, after being separated from the body of the fœtus, presents only a slight running, produced by the small quantity of blood contained in the fœtal placenta.

Finally why fœtuses can survive not only several hours when their mother perishes from hemorrhage, but can also preserve more or less the quantity of blood they generally possess.

§ 2581. The internal or fœtal placenta is composed only of numberless ramifications of the umbilical arteries and veins, surrounded by a vaginal prolongation of the chorion.

The arteries and the veins always proceed together and are very much curved, like the trunks; their final ramifications even accompany each other constantly, so that we find a small artery and vein inclosed in the same vaginal prolongation of the chorion.

This arrangement however occurs only in the latter periods of pregnancy; for during the early stages, the vessels of the fœtal placenta are single and only venous, like those of the chorion in general.

Besides these vessels, we find in the placenta white tendinous filaments which arise from the chorion, enter with it between the vascular trunks, and seem to be only obliterated vessels, which are often half open and receive injections.

If we except a considerable and oblique anastomosis between the two umbilical arteries at the base of the placenta, their subordinate branches do not communicate from one lobe to another within this body. There is no other anastomosis between the branches of the

* In the experiments of Rœderer, Wrisberg, and Osiander, (Rœderer, *De vi imaginationis in fœtum negandâ*, Gottingen, 1756.—Wrisberg, *Obs. de struct. ovi*; in the *Comment.*, vol. i. p 618.—Osiander. *Annalen*, vol. i. pt. p. 27-28), which we have repeated with the same results on dogs, cats, and rabbits.

umbilical vein. On the contrary the arteries and veins are continuous by proportionally very large anastomoses.

This portion of the placenta is proportionally of a very loose tissue; the solidity of the whole mass depends on that of the next portion.

The placenta has no lymphatic vessels; and we cannot strictly demonstrate in it the existence of nervous filaments.

§ 2582. The uterine or external portion of the placenta is much firmer than the internal, and formed by the membrane similar to the deciduous membrane mentioned by us above.

This membrane covers its outer face, and gives it a warty appearance; but at the same time it sends internally numerous irregular prolongations, which penetrate between the most minute ramifications of the umbilical vessels, with which they form alternate elevations and depressions.

The uterine placenta, like the whole deciduous membrane which corresponds to it, is formed by the uterus, and its vessels are prolongations of the uterine vessels.

The arteries are very tortuous, and the diameter of the largest is nearly a line. The veins, which are less tortuous, but which go obliquely to the placenta, are infinitely broader. Numerous ramifications of veins arise from the deciduous membrane, which, after uniting in trunks, are distributed principally on the edge of the placenta.

The arteries and veins communicate in the uterine placenta, not by anastomoses, but by large cellules which may be completely filled, either through the venous or arterial trunks, and in which the injection is always effused before passing from the arteries into the veins.

These cellules should be considered as the larger openings of the vessels, since they have no special membranes, and form also large islands.

§ 2583. Notwithstanding the separation of the two circulations in the placenta, there is, however, between its two constituent portions and their vessels a relation of mutual action, which may be compared to that existing between the air and the blood in the lungs, or between the food and the chyliferous vessels in the intestinal canal.

§ 2584. The uterine placenta is only a transient production, of which the uterus is in great part disencumbered when the fœtal placenta is expelled, although a portion of the deciduous membrane is not perfectly detached from the inner face of the organ until several days after delivery.

From this intimate connection between the uterine placenta and the uterus, although the section of the cord occasions only a slight and momentary flow of blood, as we have said above, there is, on the contrary, a greater or less hemorrhage from the rupture of its vessels when this portion is detached, which is soon stopped by the contraction of the uterus.

IV. UMBILICAL VESICLE AND ALLANTOID MEMBRANE.

§ 2585. Beside the membranes hitherto mentioned, the existence of which is certain, there are two not so generally admitted, but which are similar in form and situation, but differ from the two preceding in these two respects. They are the *umbilical vesicle* and the *allantoid* membrane. These two membranes do not form superimposed sacs and envelops of the fœtus, but are situated between the chorion and the amnios. They do not continue as long as the other two membranes, since they disappear, or at least become inactive, at the third month of pregnancy. They however cannot be confounded with each other, nor can we suppose, with Lobstein, for instance,* that the umbilical vesicle of man is the allantoid membrane of animals. They are two entirely different organs, which coexist in most vertebrated animals, and apparently in man also.

A. UMBILICAL VESICLE.

§ 2586. The *umbilical vesicle* (*V. umbilicalis*, s. *saccus vitellarius*, s. *vesica vitellaria*, s. *intestinalis*, s. *processus infundibuliformis*, s. *hydatis funiculi*) is constant. Although Osiander has asserted that it should be considered as a pathological phenomenon, occurring only in monstrosities,† it really exists in every ovum during the early months of pregnancy.

The umbilical vesicle of man corresponds neither to the allantoid membrane of the mammalia‡ nor of birds: for the arguments drawn from its constancy, transparency, the clear and limpid fluid which fills it, its situation between the other membranes of the ovum, and the existence of vessels on its surface, adduced in favour of this comparison, are so many circumstances which demonstrate still better its analogy with the umbilical vesicle of the mammalia, and the vitelline sac of birds.

The nature of its vessels and its connections with the intestinal canal also support this analogy. Besides as the allantoid membrane is independent of it in the mammalia and in birds, and probably also in man, Lobstein's opinion cannot be admitted.

§ 2587. This vesicle is as much larger proportionally as the fœtus is younger, and it at first probably exceeds it in size; at least Lobstein has figured a case of this kind,§ and we have one almost similar before us.

* *Loc. cit.*, p. 44.
† *Salzburg med. chir. Zeitung*, 1814.
‡ Lobstein, *loc. cit.*, § 41-45.
§ *Loc. cit.*, tab. i.

The umbilical vesicle figured by Lobstein is the largest known. 'e may judge from it that the organ is at first about six lines in ameter.

The largest umbilical vesicles before us are one half or more naller: this agrees with the dimensions given by most authors.

§ 2588. This organ is at first situated directly against the anterior ce of the fœtus;* but it removes from it after the end of the first onth, and is then situated on the outside of the umbilical sheath.

§ 2589. We know nothing certain in regard to the period when the ubilical vesicle appears. Judging from analogy with birds, as it rresponds to the vitelline sac, we might conclude that it arises fore all other parts of the ovum, and on this account it has even en asserted that the *false germs* are umbilical vesicles, and not sacs rmed by the chorion and amnios, as is generally supposed.† lthough the received opinion be not perhaps applicable to all cases, e however shall continue to follow it until the contrary is proved by ositive facts.

According to Hunter,‡ the umbilical vesicle sometimes continues the end of pregnancy; but it is not larger at this period than in n ovum of two or three months, and is from half an inch to an inch nd a half distant from the insertion of the umbilical cord in the acenta. We regard this fact as very rare, having found it only rice in a great number of deliveries.

§ 2590. The umbilical vesicle is formed by rather a thick granular embrane, which does not tear when forcibly distended with water.§ gradually collapses, is covered with wrinkles, and becomes opaque. ne omphalo-mesenteric vessels are distributed in it.

It contains a whitish fluid, which gradually diminishes, becomes ick, and finally hardens.

§ 2591. We have treated of its connections with the fœtus at some ngth in the history of the development of the intestinal canal, and e have attempted to demonstrate that very probably it communicates th the ileon by the omphalo-mesenteric vessels and by a canal.

§ 2592. Its constancy, its great size in the commencement, and its robable existence before other parts, prove that it takes a very nportant part in the development of the fœtus.

Judging from what occurs in birds, its contents pass into the body the fœtus, and serve for nourishment, like yolk to the chicken. It owever disappears sooner than the vitelline sac.

§ 2593. Opinions are still divided on the question whether there as in all the other mammalia, an *allantoid membrane* (*allantois*, s.

* Lobstein, *loc. cit.*, p. 46.
† Oken, *Beyträge*, pt. ii. p. 83.
‡ *Anatomie des schwangern Uterus*, p. 68.
§ Lobstein, *loc. cit.*, p. 43.

membrana media,)* which communicates with the bladder through the urachus.

Needham,† Hale,‡ Bidloo,§ Hoboken,|| de Graaf,¶ Littre,** Rouhault,†† Neufville,‡‡ Haller,§§ Emmert,|||| Joerg,¶¶ Dutrochet,*** and Cuvier,††† admit it. Paré,‡‡‡ Harvey,§§§ Ruysch,|||||| Heister,¶¶¶ Troortwyk,**** Neu,†††† Albinus,‡‡‡‡ A. Monro,§§§§ Danz,|||||||| and Hunter,¶¶¶¶ deny it. Although some of the numerous facts adduced to support it are false, and others but slightly conclusive, we however agree with the first of these two opinions, because we have found in a human fœtus about four weeks old, between the chorion and the amnios, and independent of the umbilical vesicle, a larger pouch, with thin parietes, collapsed, and containing a limpid fluid.***** We have seen this since.

Its existence may be supported:—

1st. By the cases where we have found in the other membranes a pouch different from the umbilical vesicle. In fact some observations of this kind are very suspicious; but we have several times been satisfied of the existence of a delicate layer, differing from the rest of the ovum, which first forms a close vesicle until about the end of the second month of pregnancy, and which afterward appears as a thin lamina.

2nd. By the space between the amnios and the chorion. This space is greater in the early periods than afterward, and is filled by

* R. Hale, *The human allantoid discovered*; in the *Phil. trans.*, p. 270.—Sellius, *De allantoide*, Kiel, 1729.—C. de Neufville, *De allantoide humanâ*, Leyden, 1726.—Haller, *De allantoide*, 1739.—J. G. Betschler, *Diss. num a fœtu urina secernatur et secreta excernatur*, Berlin, 1820.

† *De formato fœtu*, c. iii.

‡ *Loc. cit.*

§ *Tab. anat.*, 58, lit. E.

|| *Anat. secund. hum. rep.*, p. 428.

¶ *De mulier. org.*, cap. xv.; *Opp. omn.*, p. 283.

** *Mém. de Paris*, 1701, p. 115.

†† *Osservaz. anat. fis.*, Turin, 1724, p. 21.

‡‡ *Loc. cit.*

§§ *Loc. cit.*

|||| *Nachtrag zu den beiden Abhandlungen über das Nabelbläschen*; in the *Archiv für die Physiologie*, vol. x. p. 373.

¶¶ *Die Zeugung*, p. 288. Joerg however draws his conclusions solely from the space often existing between the chorion and the amnios.

*** *Loc. cit.*

††† *Mém. de Mus.*, vol. iii.

‡‡‡ *Anat. chir.* l. ii. c. xxxv.

§§§ *Exerc. de gener. et de memb. et humur.*

|||||| *Thesaur.* 3, no. 57; *th.* 9, no. 21.

¶¶¶ *Eph. nat. curios. cent.* II., obs. 190.

**** *De utero gravido*; p. iii., *De allantoide*.

†††† *De diff. fœt. et adulti*, p. 105.

‡‡‡‡ *Annot. acad.*, l. i. c. xix. p. 75.

§§§§ *Essays of a soc. of Edinb.*, vol. ii.

|||||||| *Loc. cit.*, p. i. § 12.

¶¶¶¶ *Anatomie des menschlichen schwangern Uterus*, p. 84.

***** *Deutsches Archiv. für die Physiologie*, vol. iii. tab. i. fig. 2

'fluid which is sometimes very abundant at parturition, and which orms what is termed the *false waters.*

3rd. By the analogy with other animals.

This vesicle has always very thin parietes, which are more delicate ian those of the other membranes.

It is not certain that it communicates at any period with the ura-nus. Dutrochet admits this communication, but has never observed . It however probably exists, at least in the early periods of gesta-on, either from analogy, or because the urachus makes part of the mbilical cord, or finally from the possibility of following it there ore or less to the placenta,* of introducing into it a liquid,† and ven of demonstrating within it an immediate connection between is body and the allantoid membrane.‡ We have been able more r less easily to follow the urachus in almost its whole length at very period of pregnancy, and even to fill it partially with mer-ry: but we have never been able to prove that it communicated ther with the space between the two proper membranes, or with e allantoid membrane.

We do not know certainly how long the allantoid membrane exists. We have seldom been able to trace it evidently in the latter months f pregnancy.

§ 2594. The allantoid membrane is generally considered as the eservoir of the urine, which is carried to it by the urachus from the ladder.

This is the opinion of most physiologists and physicians.

Joerg thinks even that the allantoid membrane itself secretes rine,§ which is not very probable, since the kidneys exist, and are ore developed than at subsequent periods of life.

Harvey,‖ Lobstein,¶ and Oken,** have advanced another pinion.

Harvey maintains that the liquid of the allantoid membrane is not rine, but a nutritious fluid:—

1st. Because it exists in the ova where there is no fœtus.††

2nd. Because it is abundant when the organ is formed.‡‡

3rd. Because the allantoid membrane is at first proportionally and ven absolutely much larger than subsequently,§§ while it is admitted at the secretion of the urine is in a direct ratio with the advanced ge of the fœtus.

* Albinus, in Neufville, p. 42, 43.—Hunter, *loc. cit.*, p. 45.—Cruikshank, *ibid.*

† Noreen and Rœderer.—A. Monro, in the *Edinb. phys. essays and obs.*, vol. i. . 485.—Ridley, *Obs. med. pr.*, London, 1703.

‡ Albinus, in Neufville, p. 47. But this undoubtedly refers to the umbilical esicle.

§ *Zeugung*, p. 298.

‖ *De gener. anim.* Amst., 1662, p. 361.

¶ *Loc. cit.*, p. 53.

** *Beyträge*, pt. i. p. 29.

†† Harvey.

‡‡ *Id.*

§§ Lobstein, p. 54.

4th. Because we can not conceive why the urinary secretion should be the most important function in the fœtus.*

4th. Because the allantoid membrane is deficient in some mammalia, and it is very improbable that the fœtuses of some animals should secrete urine and others not.†

6th. Because it is very difficult in the nearly perfect fœtus of the adult to pass air from the bladder into the allantoid membrane.‡

7th. Because the fluid would not be excretory, since a considerable number of umbilical veins (absorbents) are distributed in the enveloping membrane.§

8th. Because the fluid differs from the urine.||

But all these arguments prove nothing against the old opinion, or in favour of that of the writers who adduce them.

1st. The existence of the allantoid membrane and its fluid without a fœtus proves nothing, and that considered as such may be something else, or the fœtus may not be deficient.

2nd. and 3rd. The size of the allantoid membrane and the quantity of its fluid during the early period of gestation, are explained very well by the more rapid progress of all the formations at this period, and because very probably the other excretions do not take place then, or at least but slightly.

4th. The size of the allantoid membrane does not prove that the urinary secretion is the most essential of all the fnnctions, but only that it replaces in great part all the other excretory systems, from the simple reason that the products of the action of these latter had been in contract with the fœtus during the whole of pregnancy.

5th. This fact is entirely incorrect, for the allantoid membrane is very constant. Farther its absence might possibly be compensated for in some way.

6th. In this case the same difficulty exists in passing air from the allantoid membrane into the bladder,¶ while it is very easy during the early periods or gestation, as we have more than once proved. It follows then at most from this fact, that the quantity of urine secreted gradually diminishes, and collects in the bladder.

7th. This objection rests upon confounding the allantoid membrane with the chorion. The vessels do not belong to it, but to this latter; at least they do not absorb within it, but in the cavity of the uterus.

8th. It does not follow, for several reasons, from the fact reported, that the liquid was not urine.

We cannot consider the allantoid membrane as the formative membrane of the urinary and genital apparatus, or of the bladder,** for it

* Id., *ibid.*
† Id., *ibid.*
‡ Oken, p. 58.
§ Harvey.
|| Oken, p. 39.
¶ Ibid., p. 39.
** Joerg, p. 298.

birds it arises very evidently from the urinary system, and does not exist in the ova of the batracia.

The bladder is not formed by the urachus;* but the canal corresponding to the bladder and urachus, which was at first uniformly narrow, enlarges at its lower part, is completely developed and becomes the bladder, while the upper part, which is not developed in the same manner, remains the urachus.

II. ORIGIN OF THE OVUM, AND THE ORDER IN WHICH ITS PARTS FORM.

§ 2595. It is extremely difficult to determine the period at which the ovum first appears. Although the duration of pregnancy is ascertained with certainty, it does not necessarily follow that the new organism always begins to form at the same period, for the development of the embryos of birds proves that although the ova are all matured at the same period, there is, however, a great difference between embryos of the same brood in the development of different organs, or of the whole body.

From the eighth day after coition a tendency to form the deciduous membrane, and also the fœtal portion of the ovum,† has been observed.

From the rapidity with which the transitory or permanent parts of the body form successively in the superior animals, and from the proportionally very small number of perfect observations on the development of the ovum in particular, it is extremely difficult to determine if the different parts of this latter, described in the preceding article, form at the same time or at different periods, and also the order of their appearance, and their part in the formation and development of the fœtus.

Very probably, however, the deciduous membrane begins to form at the same time as the ovum, or the fœtal portion of it, since we observe the changes in the uterus, connected with its appearance, very early, even before the latter is seen there.

Hitherto physiologists have generally considered the chorion and the amnios as the most essential parts of the ovum, those which arise first; and even now the external of the two membranes to which the least advanced ova can be reduced is considered the chorion, and the internal as the amnios.

Analogy with the development of animals inferior to the mammalia, however, renders it very probable that the umbilical vesicle is developed the first, and that the other membranes form after it, since in the animals mentioned, the vitelline sac, which corresponds to the umbilical vesicle, appears long before all other parts of the ovum, which precede only the body of the fœtus.

* Ibid., p. 290.
† Home, *Phil. trans.*, 1817, pt. ii. p. 256-261.

III. FŒTUS.

§ 2596. It is very difficult to determine precisely the period when the human fœtus* forms. This ought not to surprise, for this is still more uncertain in the history of the oviparous animals even, notwithstanding the greater facilities they present to the observer, and the numberless observations upon them. It however is certain that a greater or less length of time elapses after coition, followed by impregnation, before the ovum becomes visible.

We may admit generally that it appears in the second week after coition, and there are very probably greater or less differences in this respect. Haller's† opinion, however, that the fœtus does not become visible till the end of the third week does not seem to be entirely correct since it does not agree, among others, with Home's observation mentioned in the preceding article.

I. MODE OF ORIGIN.

§ 2597. The problem of the mode of origin of the fœtus is still more difficult, and all that has been said on this subject is reduced almost to hypothesis, instead of obervations and facts.

It is certain, however, that the fœtus is united to its membranes from the first.

The contrary opinion that it arises in the waters of the amnios, without any adhesion, cannot be sustained. It is supported by the following arguments.‡

* Beside the works already cited in the course of this book, consult also; 1st. On the form and structure of the fœtus:—Cassebohm, *De differentiâ fœtûs et adulti anatomicâ*, Halle, 1730.—C. J. Treu, *De differentiis quibusdam inter hominem natum et nascendum intercedentibus*, Nuremberg, 1736.—Hebenstreit, *Programma de anatome hominis recens nati*, Leipsic, 1739.—Treu, *Descriptio et delineatio embryonum humanorum*; in the *Comm. Nor.*, 1739.—J. G. Rœderer, *De fœtu perfecto*, Gottingen, 1750.—J. A. Langguth, *De anatomiæ embryonis trium cum dimidio mensium*, Wittemberg, 1751.—J. G. Rœderer, *De fœtu observationes*, Gottingen, 1758.—H. A. Wrisberg, *Descriptio anatomiæ embryonis observationibus illustrata*, Gottingen, 1764.—A. B. Koelpin, *De fœtûs et adulti differentiis*, Gripswald, 1764.—J. F. Dietz, *Differentia fœtûs ab adulto*, Giessen, 1770.—A. and F. Rosslein, *De differentiis inter fœtum et adultum*, Strasburgh, 1783.—Autenreith, *Supplementa ad historiam embryonis humani*, Tubingen, 1797.—S. T. Sœmmerring, *Icones embryonum*, Frankfort, 1799.—2nd. On its mode of existence:—Rose, *De naturâ embryonis humani*, Leipsic, 1774.—J. Van Solingen, *De vitâ fœtûs propriâ*, Utrecht, 1782.—A. Brendel, *De nutritione fœtûs in utero materno*, Wittemberg, 1704.—Treu, *De chylosi fœtûs*, Altdorf, 1715.—Bernhardi, *De nutritione fœtus in utero*, Halle, 1732.—J. de Diest, *An sui sanguinis solus opifex fœtus*, Paris, 1725.—A. Nann, *Eversa vasorum rubrorum uteri anastomosis et communicatio cum placenta*, Erford, 1751.—R. Forsten, *Quæstiones medicæ*, Leyden, 1774.—Schaffer, *De commercio fœtûs cum matre per nervo*, Erlangen, 1775.—Richard, *De modo nutritionis fœtûs*, Erford, 1783.—Stoy, *De nexu inter matrem et fœtum*, Halle, 1786.

† *El. phys.*, vol. viii, p. 61.

‡ C. F. Burdach, *De primis momentis formationis fœtûs*, Konisberg, 1814.

1st. The nervous system, which forms before all the other parts, is never united with the ovum.

2d. A film is gradually developed in the midst of the fluid of the amnios, which is the fœtus.

3d. The fœtus is straight originally, although it is the general opinion that it curves from the moment of its origin.

All these arguments are easily refuted.

In fact the part first formed has not been strictly determined. It seems probable to us that the rudiment first seen is the common base of several parts, and even in the inferior animals one organ, and in he most inferior the apparently homogeneous substance of their body epresents several organs at the same time. Secondly, we can well onceive that the nervous system appearing first, it is primarily connected with the envelops of the ovum.

The second argument does not rest upon facts; and we do not see vhy the fœtus could not be formed straight as well as curved from some portion of the ovum.

Finally, another circumstance also exists against this opinion, viz. he membrane of the amnios and the liquid it contains certainly appear after the fœtus in birds, and the fœtus of these animals is connected with the ovum at its first appearance.

The same is true doubtless of the human fœtus. It is developed hen on the ovum, and at the expence of one of its parts.

Another question now presents itself. At the expence of what part f the ovum is it developed, and how does this development occur?

Judging from analogy with the other vertebrated animals, the huan fœtus is very probably developed upon the umbilical vesicle, and t its expence. But analogy alone does not merely favour this hypoesis, in support of which we may also allege the greater considerble size of the umbilical vesicle at first, and the position of the lower art of the fœtus directly upon this pouch.

II. FORM.

§ 2598. After its origin the fœtus presents an almost infinite numer of degrees in its form and structure, the most general of which ave already been mentioned in the introduction, while treating of e eight laws of the organic formation, or in descriptive anatomy, in ating in regard to each system and each organ the peculiarities hich characterize it at different periods of its development.

The body of the fœtus is longer at its first appearance than it is ubsequently.

The portion of its body which appears first corresponds almost exusively to the trunk; we only remark at its upper part a small rominence separated from the rest by a fissure, which is by no eans equal in thickness to the central part of the body. This proinence is the rudiment of the head.

As yet there is no trace of extremities nor of the other prominences particularly of the nose, the ears, and the genital parts.

The fœtus has then the form of a worm.

It is entirely or almost entirely straight; we only remark that the dorsal face is slightly convex, and the abdominal slightly concave.

It is attached to the inner membrane of the ovum directly, or by a very short umbilical cord at its lower extremity, or by the part of its body directly above this extremity.

When the umbilical cord is inserted above the lower extremity of the body, this extremity slightly curves from behind forward, in the form of a tail.

All the openings which afterward exist are now completely closed.

The head gradually becomes proportionally large, so that towards the commencement of the second month it forms nearly half of the whole body. It is generally smaller before and after this period.

The body of the fœtus curves much at its upper and lower extremities: the head is continuous with the trunk at a right angle, and its lower portion, which corresponds with the chin, is attached only to the top of the chest; the trunk is perfectly straight; there is no trace of the neck externally until the end of the second month.

Until the middle of the third month the lower extremity of the vertebral column is curved from behind forward and from below upward, projects below the anus, and represents the rudiment of a tail, which is at first very long; this gradually shortens and finally disappears entirely, but it is always attached by its inner face.

The limbs appear in the fifth week of pregnancy; the superior generally a little sooner than the inferior. They then have the form of small tubercles terminated by a blunt summit. The superior are situated directly below the head, and the inferior directly before the caudal extremity. Both proceed from behind forward, but a little also from within outward, on account of the greater development of the abdominal cavity. Sometimes also the superior go a little from above downward, and the inferior slightly from below upward, but this arrangement is by no means constant; they often also, particularly the inferior, assume an entirely opposite arrangement.

During the sixth week, and until the seventh, the stump which first appeared and which gradually lengthened, is divided into a peripherical and a central segment; these segments correspond to the hand and fore-arm, to the foot and leg.

One or two weeks afterward a third appears, which represents the arm and the thigh.

The segments formed last are much shorter than those which existed previously, although the contrary is true when the fœtus is perfectly developed.

About the period when the stump of the limb begins to divide into an internal and an external part the latter becomes round, and enlarges at its loose extremity, and a single band-like eminence is frequently developed at its summit, from which it is separated by a depression.

This eminence soon gradually divides to form the fingers, which are at first proportionally short and thick, and which until the third month are still united by a thin substance similar to the membrane between the toes of web-footed animals, or the bones of the fins in fishes.

This uniting substance, this thin membrane, gradually disappears from the summit to the base of the fingers and toes.

The upper limbs appear before the lower; they also pass through all their successive degrees of formation more rapidly than the latter. They are for a long time absolutely larger, so that at five years of age the four limbs have nearly the same length.

When the limbs appear we begin to see also the external genital organs, the nose, the eyes, the ears, and the mouth, the successive development of which follows the course mentioned when treating of each of these organs.

The insertion of the umbilical cord gradually ascends. The umbilicus, however, is still proportionally much nearer the symphysis pubis in the full-grown fœtus than in the adult, which difference is directly connected with the gradual diminution of the liver.

III. GROWTH.

§ 2599. The fœtus, which is at first only some lines long, gradually becomes in ten lunar months about a foot and a half in length, and about six pounds in weight.

The increase is very rapid at first, and afterwards is gradually slower. It is asserted that it diminishes at the second month, that it becomes more active in the third month, but especially during the second half of the fourth, that it is evidently most rapid in the centre of pregnancy, and that it consequently becomes slower until the end of pregnancy.* This proposition is proved with difficulty, for individual differences may easily lead into error. We may however conceive it to a certain extent, by attributing this slowness to the disappearance of the umbilical vesicle about this period, and that it is not completely replaced by another mode of nutrition.

IV. VITAL PHENOMENA.

§ 2600. At the period of its appearance the fœtus never makes part of the organism of the mother. Its relation with the mother are the same as those between the child and the external world. It lives a peculiar life, as is demonstrated by the mode of connection between the two organisms mentioned above.

* Autenreith, *Suppl. ad. hist. embryon.*, p. 415.--Sœmmerring, *Icones embryonum*, p. 3.

Among the vital phenomena those connected with the formation are developed in the greatest degree, and at the expence of the rest. This is proved by the rapidity with which the fœtus increases in weight and volume.

But the different functions of nutrition take place precisely in the same manner in all essential respects before and after birth. We have already mentioned the activity of the urinary secretion. The intestinal canal and the skin are also active.

§ 2601. We find very early in the intestinal canal of the fœtus a fluid which has not the same qualities at all periods. Until about the centre of fœtal existence this liquid is whitish and mucous: but it afterwards changes to a yellowish green, which is thicker and more viscid. It gradually becomes of a darker colour in the large intestine, until finally in the latter periods of pregnancy it has the same qualities in the whole intestinal canal, so as to distend it. It is termed the *meconium*. It is formed of about two thirds of water, about one third of a peculiar substance, similar to vegetable matter, and of some hundredths of mucus.*

Opinions vary in regard to the origin of the meconium. Some consider it a residuum of the fluid of the amnios swallowed by the fœtus; others think it formed from the secretion of the intestines.

Although the fœtus very probably swallows and digests the fluid of the amnios, yet as meconium has been found also in the intestines of fœtuses destitute of a head and mouth,† in a portion of the canal situated below a septum which interrupted the continuity of the tube,‡ in a separate end of the intestine which was closed in every part, in the rudiment of a fœtus adhering to another regularly formed fœtus,§ and finally in the intestines of another perfect body,|| it is clear that the deglutition of the waters of the amnios are not necessary to produce it. If consequently we sometimes find it only above the obstacle, when the intestinal canal is obliterated in any part,¶ we must not conclude from this that the fluid of the amnios has been swallowed, and that the meconium is formed from it,** but it follows at most that the secretion takes place principally at the upper part of the alimentary canal. We thus explain the peculiar colour of the meconium, which might be attributed to the bile, since the tint of this fluid changes at the same time with it,†† as we have ascertained, and

* Bouillon-Lagrange, in the *Annales de chimie*, vol. lxxxvi. and lxxxvii.

† R. de Graaf, *De mulier. org.*; in the *Opp. omn.*, p. 292.—Odhelius, in the *Schwed. Abhandlungen*, 1785, p. 176.—Gilibert, *Advers. med. pract.*, p. 132.

‡ Pied, in the *Journ. de med.*, an. x., frimaire.

§ Simmons, *Medical facts*, vol. viii., London, 1800, p. 7.

|| Brugmans, in Bernard, *Quæst. var. med. argum.*, Leyden, 1796. *De meconi. origine*, p. 31.

¶ Horch, *Eph. nat. cur.*, dec. iii. a iii. p. 188.—Desgranges, in the *Journ. de méd.*, an. x., thermidor.—Osiander, *Neue Denkwürdigkeiten*, vol. i, p. 179.

** Osiander, *Handbuch der Entbindungskunde*, vol. i. p. 237.

†† Lobstein, p. 132.

as in an acephalous full-grown fœtus the intestine contained a viscous semitransparent mucus, not coloured black.*

It, however, remains to be ascertained whether this hypothesis has any foundation, since the authors who describe the cases mentioned by us formally indicate the existence of a yellow matter having the qualities of meconium, and chemical analysis has not proved in it the existence of bile.†

However this may be, the bile seems to have some part in producing the meconium. In fact in some cases, particularly in that mentioned by Sims, and the subject of which was a child two years old, obliteration might be caused consecutively; in others, as in that described by Brugmans, some difference is stated between the meconium in that portion of the intestine which communicated with the biliary system and that inclosed in the lower intestine. Thus although the bile is not found in this fluid, it may perhaps contribute to produce it. Possibly also when the liver is deficient the intestinal canal supplies the action of this gland.

§ 2602. The surface of the body of the fœtus is covered with a substance of a peculiar character, termed the *vernix caseosa*.‡

This substance is yellowish white, viscous, and fatty.

From its chemical composition it is between the fibrin and the fat, and very much resembles adipocere.§

It does not exist during the whole of gestation, but begins to appear about the sixth month.

Opinions are divided in respect to its origin. Some consider it as a precipitate from the waters of the amnios deposited on the surface of the body of the fœtus:|| others think it is secreted by this latter.¶

This last opinion is very probably more correct than the other. In fact:

1st. The glandular system, particularly that of the sebaceous glands of the skin, is much more developed in the fœtus than subsequently.

2nd. The vernix caseosa is very abundant in the parts where these glands are very numerous, in the head, the axillæ, and the inguinal regions.

* Monro, *Trans. of a soc. of Edinburgh*, vol. i. p. 216.

† Simmons, *loc. cit.*, p. 7.

‡ J. J. G. Schulz, *De ortu et usu caseosæ vercinis*, Helmstadt, 1788.

§ Buniva and Vauquelin, *Annales de chimie*, vol. xxxiii.—Emmert and Reuss, *Chemischi Untersuchung des Fruchtwassers aus dem zeitigen Ei und der käsigen Materie auf der Haut des neugebornen Kindes*; in Osiander, *Annalen*, vol. ii. p. 122.

|| Boehmer, *De aquis ex utero gravid. et partur. profl*, Halle, 1769, § ii.—Schulz, *loc. cit.*

¶ Levert, *Art des accouchemens*, 1766, p. 75.—Schulz, *Anweisung zur Hebammenkunt*, Hildburgshausen, 1770, p. 49.—Wrisberg, in Rœderer, *Elem. artis obstet.*, note 37.—Emmert, *loc. cit.*, p. 134.—Lobstein, *loc. cit.*, p. 99.—Hunter, *Anat. des swang. Uterus*, p. 96.

3rd. It is found only in the fœtus: the membranes of the ovum and the umbilical cord present no trace of it.

4th. It is very similar to the substance furnished by the sebaceous glands of the glans penis, and its qualities do not allow it to be regarded as a precipitate from the waters of the amnios.

§ 2603. We shall demonstrate hereafter that the fœtus respires by means of the placenta.

We shall also mention the differences presented in it by the fœtal circulation.

§ 2604. The motions of the voluntary muscles are but slight. They generally begin to be felt about the middle of pregnancy, although we cannot conclude from this that they do not occur before, since they may be unperceived on account of the smallness of the fœtus, and the abundance of the waters of the amnios.

§ 2605. The fœtus necessarily derives in the body of the mother the materials for its growth, preservation, and its secretions. But here a question presents itself: Are there or not several modes of nutrition?

Different authors, particularly Hippocrates, Aristotle, Galen, Monro,* and Danz,† admit only one mode of nutrition, and consider the umbilical vein as the only channel through which nutrition comes to the fœtus.

Others believe in the existence of several other channels, as the skin and the system of the mucous membranes, in a greater or less extent. According to this last hypothesis, the waters of the amnios are the source of nutrition for the fœtus.

Several ancient writers, cited by Haller,‡ and among the moderns, Vas,§ Brugmans,‖ Van der Bosch,¶ and Osiander,** admit that the skin absorbs.

Opinions vary much in regard to the extent of the portion of the system of the skin which contributes to nutrition.

According to Harvey,†† Lacourvee,‡‡ Haller,§§ Treu,‖‖ and Darwin,¶¶ absorption takes place only by the intestinal canal.

Scheel*** asserts that it occurs also by the lungs, into which the waters of the amnios come through the mouth and nose.

* Monro, *Essay on the nutrition of the fœtus*; in the *Ed. med. essays*, vol. ii p. 102.

† *Zergliedlrungskunde des neugebornen Kindes.*

‡ *El. phys.*, vol. viii. p. 205.

§ C. J. Vas, *De nutritione imprimis nervosa*, Utrecht, 1789.

‖ In Van den Bosch, *De naturâ et utilitate liquoris amnii*, Utrecht, 1792.

¶ *Ibid.*

** *Handbuch der Entbindungskunde*, vol. i. p. 237.

†† *De generatione*, Amsterdam, 1662, p. 253, 368.

‡‡ *De nutritione fœtus in utero paradoxa*, Dantzic, 1655.

§§ *El phys.*, vol. viii. pt. i. p. 2 1.

‖‖ *De chylosi fœtus*, Altdorf, 1715.

¶¶ *Zoonomie*, vol. i.

*** *De liquoris amnii utilitate*, Copenhagen, 1795.

To these parts Lobstein* adds the genital organs also.

Finally, Oken† thinks that the mammæ also absorb; but instead of admitting, as had already been done,‡ that the fœtus absorbs the milk secreted by its proper mammæ, he asserts that these latter organs absorb only the waters of the amnios, and that the fluid introduced by them is carried by their lymphatic glands into the thymus gland, whence it enters the thoracic canal.

The following have been considered also as sources of the nutrition of the fœtus:

1st. The fluid of the umbilical vesicle.§

2nd. That of the allantoid membrane.‖

3rd. The gelatine of Wharton.¶

Those who maintain several modes of nutrition think that they are brought into use simultaneously or successively. The first opinion has more supporters than the second.

We can hardly arrive at positive results until we have mentioned and discussed the arguments of each party.

§ 2606. Those physiologists who think that the materials of nutrition are brought to the fœtus through the umbilical vein, rest their opinion upon the following facts:

1st. The constant and general existence of the umbilical cord, the chorion, and the placenta.

2nd. The peculiar structure of these organs, and their connections with the fœtus.

3rd. Their early appearance.

4th. The villosities of the chorion are at first only venous, so that they have no function but that of absorption.**

5th. The fatal consequences which the interruption in the circulation of the blood causes in the nutrition and vitality of the fœtus.

The arguments cited by the partisans of nutrition by the waters of the amnios generally, are:

1st. The existence of nutritious materials in this fluid.

2nd. The gradual disappearance of these materials, and the diminution of the liquid near the end of pregnancy.

3rd. The fœtus continues to live and be nourished, although the cord is altered in texture, obliterated, and even entirely separated from the body, the umbilicus being perfectly closed at birth.

* *Essai sur la nutrition du fœtus*, p. 102.

† *Zeugung*, Hamburg, 1805, p. 162.

‡ Danz, *loc. cit.*, vol. ii. p. 71.

§ Needham, *De formato fœtu*, London, 1667, p. 79.—Blumenbach, *Specim. physiolog. comp. inter animalia cal. sang. ovip. et vivip.*, Gottingen, 1786,—Id., *Instit. physiol.*, p. 449.—Sœmmering, in Haller, *Grundiss der Physiologie*, 1796, vol. ii. p. 8 0.—Lobstein, *loc. cit.*—Emmert, *Ueber das Nabelblaschen*; in Riel, *Archiv. für die Physiologie*, vol. x. p. 77.—Joerg, *Zeugung*, p. 286.

‖ Harvey, Lobstein, Oken.

¶ Lobstein.

** Lobstein, *loc. cit.*, p. 117.

4th. It is a fact that no substance can be placed next to the body, but a mutual action and reaction is established.

5th. The parts with which the fluid of the amnios is in relation possess the power of absorption.

We consider the following as facts which demonstrate absorption particularly by the skin:

1st. The experiments where the lymphatics of the skin are filled with the fluid of the amnios.

2nd. The known instances of fœtuses without a mouth and an umbilical cord.

Those who think that the mucous surfaces absorb, rest their opinion on the following arguments:

1st. The necessity that the waters of the amnios should penetrate internally in cases of fissure of the mouth and palate, although the fœtus does not become thinner.

2nd. The existence of this liquid in the upper part of the intestinal canal, the lungs, and even the vagina.

3rd. The products of digestion found in the intestinal canal.

4th. The downy hairs of the fœtus found in the meconium.

5th. The motions of deglutition observed in fœtuses immersed in the fluid of the amnios. Their attempts at biting and sucking before and after birth.

6th. The existence of the meconium at the upper part of the intestine, when the canal is interrupted in any portion of its extent.

Those physiologists who think that the liquid in the umbilical vesicle contributes to nutrition, cite:

1st. The analogy of this organ with the vitelline sac of the other vertebrated animals, and the evident passage of the liquid into the intestinal canal.

2nd. The great size of the umbilical vesicle, then its wasting, attended with a change in the nature of the fluid within it.

We have already mentioned the arguments for thinking that the liquid of the allantoid membrane contributes to nutrition.

Those who think that the gelatine of Wharton also assists in this function, adduce:

1st. Its nutritious properties.

2nd. Its abundance in the early periods of fœtal existence, which is connected with the shortness and size of the umbilical cord, since the size of this cord does not depend solely on the presence of a greater number of parts within it.

3rd. The observations of Noortwyk, Rœderer, and Uttini, which have shown that fluids can be made to pass into the gelatine of Wharton.

4th. The greater proportional development of the vessels and glands of the lymphatic system in the upper half of the anterior face of the

body on leaving the umbilicus, but principally in the anterior mediastinum,* which fact we have always proved.

§ 2607. Those who admit but one mode of nutrition, particularly that by the umbilical vein, adduce, first, the fact that other channels, particularly the absorption of the waters of the amnios by the skin and the mucous membranes, are insufficient; and secondly, that it is indispensably necessary to the life of the fœtus for this passage should be open.

1st. The following reasons are alleged as leading one to think that nutrition by the waters of the amnios is not probable.†

a. The liquid is formed from the blood of the fœtus.

b. It contains but little nutritious substance.‡

c. A very marked alteration in its composition has no effect on the life or health of the fœtus.

d. The fœtus continues to live a greater or less length of time after the dribbling of the waters.§

e. The instances of the fœtus having lived, although the umbilical cord was interrupted, obliterated, or separated from the body, are not authentic.

f. There is a considerable quantity of the amniotic fluid at the end of gestation.||

2nd. Nutrition by the skin particularly has been opposed by the following arguments:¶

a. The caseous envelop which covers it.

b. The necessary stagnation of the liquid in the cellular tissue after penetrating it.

c. The viscidity of the waters of the amnios, which render them unfit to enter through the skin.

3rd. The arguments against the entrance of this liquid through the mouth are:

a. The want of similitude between the waters of the amnios and the fluid in the stomach.** The dissimilarity even between these waters and the meconium.††

b. The impossibility of swallowing unless respiration occurs.‡‡

c. The frequent closing of the mouth.§§

d. The fact that milk injected into the amnios does not enter the oral passages.|| ||

* Lobstein, p. 139.—Monro, *loc. cit.*, p. 113.—Van den Bosch, *loc. cit.*

† Danz, p. 59.

‡ Van den Bosch, in Schlegel, p. 458.

§ Van den Bosch, p. 458.

|| Monro, p. 166.

¶ Haller, *El. phys.*, viii. p. 205.

** Monro, p. 163.—Van den Bosch, p. 460.

†† Danz, p. 6?.

‡‡ Danz, p. 59.

§§ Monro, p. 173.—Van den Bosch, p. 458, 459.

|| || Monro, p. 175.

e. If the amniotic fluids penetrate into the oral cavity by any pressure, they would be introduced into the trachea as well as into the esophagus.*

f. Instances of acephalous and astomatous fœtuses, which, however, were fleshy.†

g. The products of digestion found in the intestinal canal prove nothing, since they may arise solely from the action of this organ,‡ and the more as meconium also has been found above the point where obliteration had occurred §

h. The existence of the meconium and the hairs in the stomach prove nothing, for hairs might be developed in the alimentary canal, and the meconium pass up through the intestines into the stomach.||

i. We may also consider deglutition and the sucking of the newly born child as valueless, since numerous other phenomena supervene at the period of birth, although the system has made no previous attempts, and the latter had already commenced before parturition by swallowing the waters of the amnios.

j. The existence of the amniotic fluid in the stomach is abnormal, and results from powerful compression.¶

4th. We have already refuted previously the arguments which go to prove that the fluid of the allantoid membrane contributes to nutrition.

§ 2608. We have now to examine whether all the arguments alleged against the hypothesis that the fœtus is nourished by the fluid of the amnios are sufficient to refute it.

Strict inquiry determines that they are not.

1st. It is not proved, and it is not even probable, that the waters of the amnios are formed from the blood of the fœtus, since the vessels of the chorion may not necessarily be other than the organs of nutrition, and the fluid of the amnios may be secreted by the uterus.

2nd. The slight proportion of nutritious materials proves nothing, because nutrition may be well performed with substances which contain less of it, and also because the fluid of the amnios at first contains more of it; finally, because the greater energy of the formative power in the fœtus is a sufficient compensation.

3rd. The third and fourth arguments prove at most only that the liquid of the amnios is not the only source of nutrition in the fœtus, or that the fœtus might exist for some time without it: even this latter circumstance does not follow, for it is not probable that the fluid of the amnios is ever reproduced after it has escaped.

* Danz, p. 59.—G. J. C, Themelius, *Comment. qui nutritionem fœtus in utero per vasa umbilicalia solum fieri, occasione monstri ovilli sine ore. et faucibus nati ostenditur*, Leipsic, 1751.—Van den Bosch, p. 459.
† Danz, p. 60.
‡ Van den Bosch, p. 461.
§ Brugmans, in Van den Bosch, p. 461.
|| Monro, p. 177, 178.
¶ Danz, p. 59, 60.

4th. We cannot apply to several well attested cases of infants being born with the umbilical cord really obliterated, the too general objection that all those of this kind are not authentic; the only conclusion however to be drawn from this is, that the fœtus can support for some time the interruption of its communications with the uterus through the medium of the cord.

5th. The existence of a great quantity of the liquid of the amnios at the end of pregnancy, is without value, since the absolute quantity of the liquid is generally very much diminished at this period. If it is less in quantity in the latter periods of gestation, the only conclusion to be drawn from this is, that it is then less necessary, which coincides with the hypothesis that it serves for nutrition, as the formative acts have then more power, and also possibly another more efficacious mode of nutrition is then developed.

The arguments adduced against nutrition through the skin are easily refuted.

1st. The vernix caseosa does not exist in the early periods of gestation, that is, when the fluid of the amnios contains most nutrition, and when the formative acts are most rapid. Even when it is seen, it does not form on the skin a uniform layer which covers it so as to prevent absorption.

2nd. and 3rd. There is no proof that the stagnation of the amniotic fluid under the skin is necessary, and of the impossibility of its penetrating farther. This stagnation, on the contrary, is very improbable.

The arguments adduced against nutrition by the mouth are not conclusive: for,

1st. The dissimilarity between the fluid in the stomach and the fluid of the amnios is easily explained by a change in these latter; farther, we have often remarked a perfect identity between the two fluids.

2nd. The impossibility of swallowing without breathing is not demonstrated, and certainly is not a fact. Farther, the fluid of the amnios might enter into all the cavities, without being swallowed.

3rd. The closing of the mouth is a useless argument, since this does not always occur, and the mouth has been observed to be open in the fluid of the amnios.

4th. The same is true in regard to the non-entrance of the milk, for in these experiments the animal was dead.

5th. The penetration of the fluid of the amnios with the trachea is unattended with inconvenience; perhaps even it is useful. Farther observation seems to demonstrate that it really occurs.

6th. The acephalous fœtuses only prove that this passage is not the only channel through which nutrition takes place.

7th. The development of the hairs is so rare a phenomenon that the constant existence of these hairs in the meconium should be considered as a very peremptory argument in favour of the introduction of the fluid of the amnios into the alimentary passages, although the presence of the meconium proves nothing. Besides, these hairs resemble the silky down of the fœtus.

8th. Although we reject, and with reason, the opinion that swallowing of the waters of the amnios would be a kind of prelude to sucking and deglutition, it does not follow that when this liquid is found in the stomach its presence should be regarded as unusual.

§ 2609. Thus the nutrition of the fœtus by the fluid of the amnios still continues at least very probable.

It is no less difficult to doubt the nutrition by the fluid of the umbilical vesicle and the gelatine of Wharton. We have reason to think that the whitish fluid contained in the placenta constantly passes into the body of the fœtus through the umbilical cord.

But it is very improbable that the fluid of the allantoid membrane contributes to its nutrition.*

§ 2610. We have now to examine if nutrition by the umbilical vein rests on as firm a base as those assert who think it the only source of nutrition.

We cannot at least deny that the contrary opinion can be maintained, since the facts alleged prove only the necessity of the circulation of the blood in the chorion and placenta, but establish nothing in regard to the function of these parts.

Farther, as the fœtus is nourished in three other modes, and as it cannot be proved that these three modes are insufficient, we have a right to admit that the circulation of the blood in the placenta by the vessels of the fœtus has not the uses commonly assigned to it, provided always that we mention others which are probable.

But this is possible. In fact this function corresponds to respiration; several physiologists, both ancient and modern, have compared the placenta to the lungs.†

The arguments in favour of this opinion are:

1st. The general necessity of respiration, which cannot be performed in any other manner.

2nd. The analogy between the pulmonary and placental circulations, the placenta and lungs both receiving the blood, from which

* G. F. St. Hilaire (*Monstruosités humaines*, p. 279) having found in the intestinal canal an anomocephalus of real fecal matters, moulded even into lumps in the post-cœcal intestine, was led by this phenomenon to examine the proper nutrition of the fœtus. He thinks that the mucus secreted in the alimentary passages, and which is in too great a quantity to be used simply as a lubricating fluid, is the aliment first digested; that it is taken up at first by the digestive organs, then by the chyliferous passages, it is the source of the nutritious fluid, which thus flows constantly into the circulatory system, and which at each passage is gradually animalized. Considered in this manner, the nutrition of the fœtus would resemble that of the adult. This hypothesis, in accordance with which the discharge of mucus would be caused by the irritation of the mucous membranes by the bile, is very ingenious, but is improbable. In fact we should be obliged to admit that the alimentary tube acts in two totally different ways in regard to the mucus, one action forming the mucus, the other converting it, changing it into chyle. F. T

† Mayow, Duverney, Vallisneri, Cheselden, Hérissant, Bœrhaave, and Jampert, in Haller, *Elem. physiol.*, vol. viii. p. 251.—Eckardt, *Questio an duæ arteriæ umbilicales fœtui pulmonum loco inserviunt*, Jena, 1761.—E. Darwin, *Zoonomie*, vol. i.—B. N. G. Schreger, *De functione placentæ uterinæ*, Erlangen, 1795.—Lobstein, *loc. cit.*—Oken, *Der Atmungsprocess des Fœtus*; in *Lucina*, vol. iii. p. 294.

the secretion and nutrition of the body are derived, and which must consequently be renewed.

3rd. The analogy between the animals which breathe by bronchiæ, and the fœtus of the animals which have lungs.

4th. The rapidity with which death ensues, when the circulation through the placenta is interrupted.

5th. The analogy with birds and reptiles, in which the blood of the umbilical vessels really undergoes through the egg-shell the changes produced by respiration.

Very probably then the blood of the fœtus is really changed in the placenta, similarly to what it is in the lungs, and the arterial blood of the mother replaces the circulating medium, which is acted upon by the oxygen.

We cannot adduce against this hypothesis that there is no difference in the colour of the blood in the umbilical vein and arteries, as several observers worthy of confidence have proved, and as we have satisfied ourselves on several occasions; for possibly the fœtus having but little need of oxygen its blood absorbs but a small quantity, and consequently its colour is but slightly changed.

Schweighæuser has advanced an opinion directly the opposite of this.* He thinks that the function of the placenta is to change that which the umbilical veins bring to it into venous blood, and which does not suffer this change in the body of the fœtus, in order to render it proper to secrete the bile and to form the solid parts, particularly the nervous system. But this hypothesis is supported by no fact, but it is opposed by several. Thus nutrition in general, and that of the nervous system particularly, is performed by the arterial blood; the bile *may* be formed from this blood. Besides, the respiratory function of the placenta is imperfect, and consequently the difference between the blood in the umbilical vein and arteries is almost nothing. We cannot consider that of the vein as pure arterial blood, since it has already circulated very extensively in the upper half of the body. Finally, in the ovum of birds the blood of the umbilical artery is black, and that of the vein is red.

The placenta then is principally a respiratory organ, by means of the circulation in the umbilical vessels.†

* *Sur quelques points de physiologie relatifs à la conception et à l'économie organique du fœtus*, Strasburg, 1812, p. 19.

† G. F. St. Hilaire (*Philosophie anatomique*, p. 538) thinks that the fœtus respires through all its pores like the aquatic insects, that it separates the air from the surrounding liquids, and that the uterus performs the part of the right ventricle by sending the amniotic fluid into all the integuments of the body. This opinion has been confirmed by Lassaigne's discovery of a gas very analogous to the atmospheric air in the amniotic fluid. Muller has enlarged upon this (*De respiratione fœtus commentatio physiologica*, Leipsic, 1823). This author thinks that the necessity of respiration of the fœtus is to that of the child as 10: 15, or as 2: 3. But the placenta also concurs in it as well as the amniotic fluids. The fine experiments of Edwards on the asphyxia of the batracia are naturally connected with this great question, and may contribute to resolve it. F. T.

The liver probably assists in this function, since the umbilical vein ramifies very extensively before carrying the blood into the ascending vena-cava.

The more gross nutritious substance is introduced through the channels mentioned above.

But all these channels do not exist during the whole of fœtal existence.

The umbilical vesicle first becomes inactive in the second month of pregnancy. After the first half of gestation, nutrition by the waters of the amnios diminishes much, because the fluid lessens in quantity and nutritious qualities, and the vernix caseosa diminishes absorption by the skin. It would seem then that latterly no other channel exists but the gelatine of Wharton.

V. DURATION OF THE FŒTAL STATE, AND BIRTH.

§ 2611. The fœtal state usually continues ten lunar months. After this period the fœtus is *born*, that is, it is detached from the body of the mother, and enters into a direct relation with the general organism, being now capable of an independent existence.

It however is frequently separated before the normal end of gestation; this is termed *abortion* (*abortus*). The union between the two organisms rarely continues too long; this is termed a *late birth* (*partus tardivus*, s. *serotinus*.)*

The fœtus cannot survive independent of the mother until the sixth month of gestation: even then it generally dies.† It has long been disputed to what extent beyond the common period the birth may be protracted; and the discussion is not terminated. The possibility of the fact cannot be doubted, and is attested by several authentic instances. We cannot, however, deny that a great many of them related depend on the necessity in order to render them legitimate, of a conception supervening in the mother, after the death of the husband.

§ 2612. Parturition is accomplished by the contraction of the uterus aided by that of the abdominal muscles. These contractions commence at the base of the organ, while the slighter fibres of the neck gradually cease to act. Hence the cavity of the uterus shortens and contracts, and consequently all parts of the organ, except the lower, greatly compress the fœtus, which escapes through the part which presents the least resistance, that is, through the dilated orifice of the uterus, whence it passes into the vagina, and then through the external orifice of the genital organs.

* *Ueber früh-und spätreife Geburten*, Mannheim, 1807.

† The case of a fœtus, said to be only five months old, which lived nine months, has recently been reported. (V. Rodman, in the *Ed. med. and surg. journal*, vol. vi. p. 455; vol. xii. p. 251.)

Usually, about as one thousand times to one, the membranes of the ovum, which enter the first, break before the fœtus has left the cavity of the uterus, and most of the fluid of the amnios escapes. After the fœtus is expelled the uterus is freed from the ovum, by the contraction of the organ following parturition, which very much diminishes the extent of the surface by which it adheres, and ruptures the vessels which unite the placenta. When the posterior fold is once detached the final contractions of the uterus cause its expulsion.

The connections between the ovum and the uterus are rarely destroyed by the first contractions of the latter, and the child is born enveloped in its membranes, like the young of the mammalia. This case probably happens only in continued pregnancies. It is normal, on the contrary, in abortion.

§ 2613. After parturition, lactation also establishes, for a greater or less length of time, a material connection between the mother and the child.

The mammæ during pregnancy are changed like the uterus. They enlarge, become more vascular, softer, and looser. Their granulations are more distinct. In a word, they resemble the other glands, the secretory activity of which continues uninterruptedly, while pregnancy assimilates the uterus to the muscles which are constantly in action.

The secretion of the milk begins in the last weeks of pregnancy, but it is very imperfect.

The human milk, like that of the other females of the mammalia, is decomposed by rest into two parts, one fat and yellowish, the other serous; the former, or the cream, divides into butter and buttermilk. The cream and the creamy milk both contain a substance analogous to albumen, the caseous substance, of which there is but little in the milk of the female, and it is there softer and less coagulable than in that of other animals. It is coagulated by heat and acids, and thus it may be obtained separately. The serous portion of the milk, when entirely freed from caseous substance, has a sweetish taste, which is owing to the sugar of milk, which abounds in the milk of the female. Many calcareous salts exist in the caseous matter. The slight quantity of this latter and its softness prevents the milk of the female from coagulating, or at least but slightly. It is asserted that its cream does not give butter, which is not true.

CHAPTER II.

OF CONCEPTION IN THE ABNORMAL STATE.*

§ 2614. The anomalies in the genital organs connected with coition, pregnancy, and parturition, are less numerous and less worthy of notice than those presented by the new organism.

I. GENITAL ORGANS.

§ 2615. An anomaly sometimes occurring in the organs of coition is the continuance of the hymen after copulation, and sometimes after parturition. It deserves attention, as it indicates that the presence of this fold is not a certain sign of virginity, and as it renders parturition difficult, particularly when the hymen is solid.

Among the anomalies of the genital organs of the female, of which we have already spoken above, the adhesion of the abdominal extremities of the Fallopian tubes with the adjacent organs, particularly with the anterior and posterior face of the broad ligaments, the uterus, the bladder, the rectum, and the ovaries, and the obliteration of their abdominal orifices, are principally results of coition These two states are observed particularly in prostitutes,† where they are probably produced by the frequent and excessive stimulation of the genital parts. They are also common in sterile females, and should be regarded as the most usual cause of sterility, since they prevent the motion of the tubes, and the entrance of the fluid from the ovaries into the uterus.

II. NEW ORGANISM.

§ 2616. We shall examine here, among the anomalies which may supervene on conception and in the formation of a new organism, only those which affect the whole new being and the ovum particularly, since we have already mentioned the deviations in the formation of the fœtus, either generally or particularly, in the several parts of this work.

1st. The first anomaly of the ovum is the place where it is formed. The anomaly is greatest in this case when the ovum is situated out of

* Wrisberg, *De secundinarum humanarum varietate*, Gettingen, 1773.— Schafer *De placentæ uterinæ morbis*, Leipsic, 1799.— Michaelis, *De placenta humana, anatomice, physiologice et pathologice considerata*, Erford, 1782.—Hebenstreit, *De funiculi umbilicalis pathologia*, Leipsic, 1747.

† Walter, *Ueber die Krankhesten des Bauchfelles*, p. 13.—Langstaff, in the *Med. chir. trans.*, vol. viii. p. 505.

the uterus. This is termed *extra-uterine conception* or *gestation* (*conceptio*, s. *graviditas extra-uterina.*)* The ovum is then developed in the ovary, in the abdominal cavity, or in the Fallopian tube.† The uterus generally changes as it does in pregnancy; this organ is enlarged, softens, and a deciduous membrane forms in it. In the cases where it is asserted that the latter did not exist, it had probably already disappeared, or it was developed imperfectly.‡ The ovum is destitute of it.

As to the fœtus:

a. It is regularly formed, a very rare phenomenon, observed principally in abdominal pregnancy.

b. It is dead; this is more frequent, and causes in the adjacent parts, principally the rectum, the integuments, or the vagina, rarely in the bladder, the formation of an abscess, and is usually discharged through the opening in pieces, more rarely entire.

c. Long before the first months of pregnancy have elapsed, and even during its first fifth, the too slightly extensible part in which the fœtus is developed is ruptured, and the mother dies from an internal hemorrhage, which termination is observed particularly in pregnancy of the Fallopian tubes.

d. The fœtus and its envelops less rarely adhere, and ossify more or less perfectly The mass often continues so for years, and the female lives.

More commonly the situation of the placenta in the uterus varies; being developed, particularly in twin pregnancies, at the lower part of the ovum, on the edge of the orifice of the uterus (*placentæ prævia*, s. *oblata*).

Finally, a more common anomaly is the twisting of the umbilical cord.

2nd. The simultaneous formation of several ova and fœtuses. The following are the most general remarks on this subject:

a. There is generally a predisposition to this anomaly, since the same parents and the same mothers produce several twins.

b. The number of coexisting fœtuses is never more than five. We may generally admit that twin pregnancies are to common pregnancies as 1 : 100, tripulets as 1 : 1000, and quadrupulets as 1 : 50,000-60,000.

* See our *Handbuch der pathologischen Anatomie*, vol. ii. p. 160-180.—J. H. Wiessmann, *Diss. de conceptione duplici uterina nimirum et ovaria uno eodemque temporis momento facta*, Marburg, 1820.—F. F. Susewind, *De graviditate ovaria*, Berlin, 1820.

† It may also be developed in the proper substance of the uterus, although not separated from the tissue of this viscus by a cyst. This has been observed by Schmitt, Hedrich, Carus, and Breschet. Carus (*Zur Lehre von Schwangerschaft und Geburt*, Leipsic, 1822) thinks, but wrongly, that in these cases the ovule glides and lodges between the peritoneum and the uterus. F. T.

‡ This occurred in a case reported by Langstaff. (*Med chir. trans.*, vol. vii. p. 41.)

c. Generally in a case of twins or triplets the placentas are united in one, but there are two or three choria, two or three amnia, and two or three umbilical cords, so that the two or three fœtuses are entirely separate. When two are situated in the same cavity the intermediate septum has evidently been destroyed.

The umbilical vessels usually communicate on the inner face of the placenta by a large transverse anastomosis, which arises at the root of the cord. This anastomosis is rarely deficient. This has been wrongly termed a third placenta.*

We do not as yet know how the umbilical vesicle is arranged where there are numerous fœtuses.

d. In regard to the fœtuses, even when there are but two, one and sometimes both are small and imperfect, often to a great degree, for most monsters which are very abnormal are generally twins.† This phenomenon is still more evident when there are more than two fœtuses, for then all are generally smaller, and are not nourished as well as usual. Sometimes also the existence of two fœtuses causes the death of one of them at a more or less advanced period.

e. In a twin pregnancy, and still more in triplets, parturition usually occurs before the regular period of gestation. Generally all the fœtuses, and even those which are dead, leave the uterus at the same period. Sometimes, however, one of the two is expelled prematurely, while the second remains until the regular period, and is then born.‡ In some cases, but this is less remarkable, the dead infant is not born till some days after the other, which is perfectly full grown.§

The fœtuses which coexist in the uterus have generally been produced by the same generative act. They are formed much less commonly by several successive actions; this constitutes *superfœtation* (*superfœtatio.*)‖ The possibility of this fact is proved, first, by cases where the woman has borne two children of different colour, and asserted that she had cohabited with men of different races; secondly, by those, although they are less authentic in fact, which mention full grown children born at an interval of several weeks, and even several months.

§ 2617. Superfœtation is explained:

1st. By the existence of a more or less divided uterus.¶

2nd. By a productive coition, followed by another also productive, before the ovum produced by the first had arrived into the uterus.**

* Stalpart van der Wiel, cent. i. p. 75.—Otto, *Path. Anat.*, p. 38.

† Meckel, *Handbuch der pathologischen Anatomie*, vol. i. p. 55.

‡ J. Chapman, *Singular case of expulsion of a blighted fœtus and placenta at seven months, a living child still remaining the full period of utero-gestation*; in the *Med. chir. trans.*, vol. ix. p. 194.

§ Clarke, in the *Med. and phys. Journ.*, vol. xvi. p. 53.

‖ J. P. Gravel, *De superfœtatione conjecturæ*, Strasburg, 1738.—M. Tydeman, *De superfœtatione*, Utrecht, 1783.—T. Roose, *De superfœtatione nonnulla*, Bremen, 1801.—J. C. Varrentrapp, *Comm. in T. Roose de superfœtatione*, Frankfort, 1803.

¶ Gravel, Roose.

** Varrentrapp.

3rd. By the laceration of a portion of the deciduous membrane, which forms a passage for the semen to the Fallopian tube.*

Thus all the theories given are purely mechanical. These explanations are by no means worthless ; superfœtation, however, more probably depends principally on the fact that one coition calls into action several vesicles, which do not arrive at the same degree of vital activity simultaneously, even as in birds a single copulation is sufficient to impregnate a considerable number of yolks, which differ much in respect to their development.

Superfœtation may also depend, in certain rare cases, on no mechanical cause, but on the fact that the capacity of the genital organs and the whole organism of the female is not unfitted by the first conception for a second during the course of the other ; even as the disposition for contagious diseases, to which generation is so analogous, is commonly lost by the first infection, although a second supervenes in rare cases ; or as one exanthematous affection is generally, but not always, arrested by another.

§ 2618. The new organism is sometimes destitute of certain parts. The most common anomaly in this case is the absence of the fœtus, which undoubtedly depends generally on the fact that this latter has perished sooner or later, since the ovum is commonly formed of all the parts which normally compose it, and we there perceive even more or less evident proofs of the previous existence of a fœtus.

The placenta is deficient more rarely. In one case of the kind recently described† it was asserted that the umbilical cord was attached to the inner face of the ovum in the form of a button.

The defect of an umbilical vessel, particularly of an artery, is more common.

We more rarely find the umbilical vein double, which establishes an analogy with most mammalia.

§ 2619. The deviations in the formation of the ovum relate principally to the placenta and the umbilical cord.

The placenta is sometimes but proportionally very rarely divided into several lobes (*placenta succenturiata*), only two which generally appear, although there are sometimes seven. One of these lobes is generally larger than the others. This anomaly consists in a suspension of development. We have observed it principally in pregnancy with twins, and we have always been satisfied that authors were mistaken in saying that the umbilical vessels then divided unusually soon.

This premature division of the umbilical vessels, even within the membranes of the ovum, is rare : but it is still more so for the vessels to separate on the outside of the body of the child.

* Tydeman.
† Conby, in the *Salz. med. chir. Zeitung*, 1819, no. 43.

We must arrange here the knots of the umbilical cords termed *true*, when they are real,* and *false*, when they consist only in more or less compact circumvolutions of the umbilical vessels.

§ 2620. The umbilical cord presents anomalies in its extent. Sometimes it is too short, being only four inches in length. Less frequently it is unusually long, being fifty inches in length. Sometimes also it is very thin or *lean*, which depends on the small quantity of the gelatine of Wharton. In other cases it is unusually *fat*.

The placenta is commonly much larger and much thinner than usual in abdominal pregnancy.

Here are referred the change of the vessels of the placenta into larger and smaller vesicles, entirely closed and united by contracted portions, which seem to depend on the permanence and the ultimate development of a state primitively normal.

§ 2621. Anomalies in the connections relate to those of the ovum with the uterus or fœtus. Sometimes, but rarely, the first are firm.

Sometimes the fœtus is not connected with the ovum. This phenomenon is not rare in the early periods of gestation, and we may also consider it as the result as well as the cause of the death of the fœtus.† But authors relate also cases in which this insulation was observed at an advanced age of pregnancy. Here we refer to the observations of Chatton,‡ Stalpart van der Wiel,§ Rommel,‖ Mason Good,¶ and Osiander.**

All these facts are not equally authentic. Thus Stalpart van der Wiel did not observe the case mentioned by him until several months after birth; there was at the time an inversion of the bladder; the umbilicus was situated too low, and blended with the upper part of the bladder, and seemed to be deficient.

On the other hand the fœtus is sometimes connected with the membranes of the ovum too intimately.

Here are referred the cases where the umbilical cord is inserted in an unusual part of the body, and is there attached in a greater or less extent before arriving at the abdominal cavity.††

Such are also those ‡‡ in which, besides the umbilical cord, a ligament arose from the membranes of the ovum, and was attached to the body of the fœtus.§§

* Delius, *De nodis veris in funiculo umbilicali*, Gottingen, 1805.
† Gregorini, *De hydrope uteri*, Halle, 1795.
‡ *Ephem. Gallic. ann.*, 673, fol. 69, cited by Stalpart van der Wiel, *Obs. rar.*, cent. ii. pt. ii. p. 329.
§ *Observat. rar. med. chir.*, cent. ii. pt. i. obs. 32.
‖ *Eph. nat. cur*, dec. ii. ann. vii. obs. 209.
¶ Stark, *Neues, Archiv.*, vol. i. p. 357.
** *Annalen*, vol. i. pt. i. p. 199.
†† Meckel, *Handbuch der pathologischen Anatomie*, vol. ii. pt. i. p. 56.
‡‡ *Ibid.*
§§ G. F. St. Hilaire attributes the frequent monstrosities of the fœtus which so frequently deform it, to these folds.

§ 2622. The principal alterations of texture are, the too great hardness of the membranes of the ovum, generally attended with their thickening: the development of the new formations in the placenta* or of serous cysts in the cord; finally, the changes of the whole ovum termed *moles*, and which are divided into several classes, according to the different substances which form them.

§ 2623. Parturition presents numerous anomalies, the causes of which exist in the body of the mother, or in that of the child, or in both. These anomalies become also the source of several of those mentioned when speaking of the genital organs, particularly of different deviations of formations, as lacerations of the uterus, the vagina, adhesion and obliteration of the orifice of the uterus, the vagina, and the vulva, after an injury.

* Clarke, in the *Phil. trans.*, 1789, p. 11.

INDEX TO VOLUME II.

PAGE
BOOK V. Nervous system 1
Section I. Central part 1
Chapter I. Spinal marrow 2
I. External form 2
II. Structure 3
i. Substances 5
ii. Arrangement of its great divisions . . 6
iii. Weight 9
iv. Consistence 10
Chap. II. Encephalon 10
Art. i. Medulla oblongata 11
I. Rachidian bulb 11
i. External form 12
A. Lower face 12
a. Pyramids 12
b. Olivary bodies 13
B. Lateral faces 14
C. Upper face 14
a. Medullary striæ . . . 15
b. Grey bands 16
ii. Texture 16
II. Annular protuberance 17
i. External form 17
ii. Texture 17
III. Weight of the medulla oblongata . . 18
Art. ii. Cerebellum 19
I. External form 19
i. Lateral parts 20
I. Upper lobes 20
II. Inferior lobes 21
ii. Central portion 22
I. Upper part of the middle region . . . 22
II. Cerebral valve 23

III. Lower part of the middle region . . 23
II. Texture 24
Corpus fimbriatum 26
III. Weight 27
IV. Consistence 27
Art. iii. Cerebrum 27
I. External form 27
i. Inferior face 28
I. Middle region 28
i. Cerebral peduncles . . . 28
ii. Mammillary eminences . . . 29
iii. Infundibulum and pituitary gland . . 30
iv. Root and decussation of the optic nerve . 31
v. Grey plate of the inferior wall of the third ventricle 31
II. Lateral regions 31
II. External face 33
III. Upper face 35
IV. Internal face 35
V. Circumvolutions and anfractuosities . . . 35
i. Tubercula quadrigemina . . . 36
ii. Pineal gland 37
iii. Corpus callosum 39
iv. Septum lucidum 41
v. Fornix 43
vi. Thalami optici 44
vii. Corpora striata . . . 46
viii. Tænia semicircularis . . . 49
ix. Anterior commissure . . . 49
x. Cerebral ventricles 50
a. Ventricle of the cerebellum . . 52
b. Aqueduct of Sylvius . . . 53
c. Third ventricle . . . 53
d. Lateral ventricles 55
1. Anterior horn . . . 55
2. Posterior horn 55
3. Descending horn . . . 56
II. Texture 58
III. Weight 60
IV. Consistence 60
Chap. III. Envelops of the brain . . . 60
Art. i. Pia-mater 62
I. Of the spinal marrow . . . 62
II. Of the encephalon 62
a. External pia-mater . . . 63
b. Internal pia-mater 64
i. Choroid plexus of the fourth ventricle . 65
ii. Choroid plexuses of the cerebrum . . 65

Art. ii. Arachnoid membrane 66
Art. iii. Dura-mater 70
I. Spinal dura-mater 70
II. Cerebral dura-mater 71
III. Ligamentum denticulatum . . . 73
hap. IV. Periodical differences of the nervous system . 75
I. Substance 75
i. Spinal marrow 76
ii. Medulla oblongata 77
iii. Cerebellum 78
iv. Cerebrum 79
v. Envelops 84
hap. V. Motions of the centre of the nervous system . 86
hap. VI. Centre of the nervous system in the abnormal state 87
ect. II. Periphery of the nervous system . . 103
hap. I. Nerves of the spinal marrow . . . 104
Art. i. Dorsal nerves 106
Art. ii. Lumbar and sacral nerves . . . 109
A. Anterior branches 111
B. Nerves of the lower extremities . . . 113
I. Obturator nerve 113
II. Crural nerve 114
III. Sciatic nerve 115
a. Peroneal nerve 116
b. Tibial nerve 117
Art. iii. Cervical nerves 119
A. Nerves of the upper extremities . . . 120
I. Thoracic nerves 122
II. Scapular nerve 122
III. Axillary nerve 122
IV. Radial nerve 123
V. External cutaneous nerve . . . 124
VI. Median nerve 124
VII. Ulnar nerve 125
VIII. Internal cutaneous nerve . . . 127
B. Superior cervical nerves 127
I. Diaphragmatic nerve 128
II. Fourth cervical nerve 129
III. Third cervical nerve 130
IV. Second cervical nerve 131
V. First cervical nerve 132
hap. II. Encephalic nerves 134
I. Hypoglossal nerve 137
II. Accessory nerve 140
III. Pneumogastric nerve 142
IV. Glosso-pharyngeal nerve 148
V. Auditory nerve 150
VI. Facial nerve 151

i. Ascending branches 153
a. Temporal nerves 153
b. Malar nerves 154
ii. Anterior branches or buccal nerves . . . 154
iii. Descending branches . . . 154
VII. External motor nerve 155
VIII. Trifacial nerve 157
A. First branch 160
B. Second branch 163
C. Third branch 169
IX. Internal motor nerve 173
X. Common motor nerve 174
XI. Optic nerve 175
XII. Olfactory nerve 180
Chap. III. Ganglionnary nerve . . . 181
I. Central portion 183
II. Limiting cord and its branches . . . 186
A. Superior cervical ganglion . . . 186
I. Upper branches 187
II. External branches 190
III. Internal branches . . . 190
IV. Anterior branches 190
V. Inferior branches . . . 191
B. Middle cervical ganglion . . . 192
C. Inferior cervical ganglion . . . 193
I. Cardiac plexus 194
D. Thoracic ganglions . . . 194
i. Splanchnic nerve 195
ii. Small splanchnic nerve . . . 195
E. Abdominal ganglions 195
Chap. IV. Differences in the nerves during development . 197
Chap. V. Parallel between different nerves . . 199
BOOK VI. Splanchnology . . . 206
Sect. I. Organs of sense 207
Chap. I. Organ of hearing 208
Art. i. External ear 209
A. Cartilage of the ear 209
B. Muscles of the external ear . . . 211
I. Muscles moving the external ear . . 211
A. Attollens auriculæ 212
B. Retrahentes auriculæ . . . 212
C. Attrahens auriculæ 212
II. Muscles moving certain parts . . 212
a. Tragicus 213
b. Antitragicus 213
c. Helicis major 213
d. Helicis minor . . . 213
e. Transversus auriculæ . . . 213

Art. II. Internal ear - - - - 214
A. External portion - - - - 214
I. Osseous portion - - - - 214
II. Membrane of the tympanum - - - 215
B. Middle part - - - - 216
I. Tympanum - - - - - 216
II. Eustachian tube - - - - 218
III. Bones of the ear - - - - 218
a. Malleus - - - - 219
b. Incus - - - - - 219
c. Lenticular bone - - - 220
d. Stapes - - - - - 220
IV. Muscles of the bones of the ear - - 220
a. Muscles of the malleus - - - 221
1. Tensor tympani muscle - - - 221
2. Laxator tympani major muscle - - 221
3. Laxator tympani minor muscle - - 221
b. Stapedius muscle - - - - 222
C. Labyrinth - - - - 222
I. Osseous labyrinth - - - - 222
a. Vestibule - - - - 223
b. Semicircular canals - - - - 223
c. Cochlea - - - - 224
d. Aqueducts - - - - 226
II. Membranous labyrinth - - - 228
III. Auditory nerve - - - - 229
Art. III. Differences dependent on development - 231
I. External ear - - - - 231
II. Internal ear - - - - 232
Art. IV. Abnormal state of the organ of hearing - - 237
I. External ear - - - - 237
II. Internal ear - - - - 237
A. Tympanum - - - - 237
B. Labyrinth - - - - - 238
C. Auditory nerve - - - - 239
Chap. II. Organ of sight - - - - 240
Art. I. Parts which protect the eye - - 240
I. Eyelids - - - - - 241
A. Eyelashes - - - - 242
B. Meibomian glands - - - - 242
C. Palpebral cartilages - - - 242
D. Muscles of the eyelids - - - 243
A. Orbicularis palpebrarum - - 243
B. Levator palpebræ superioris - - - 244
E. Caruncula lachrymalis - - - 244
II. Eyebrows - - - - - 245
III. Lachrymal passages - - - 245
A. Lachrymal gland - - - 245

B. Lachrymal puncta and lachrymal passages - 246
C. Lachrymal sac - - - - 247
Art. ii. Globe of the eye - - - 248
I. Membranes of the eye - - - - 249
A. External membranes - - - 249
A. Sclerotica - - - - 249
B. Transparent cornea - - - 250
B. Choroid membrane and iris - - - 251
A. Choroid membrane - - - 252
B. Ciliary body - - - 252
C. Iris - - - - 255
D. Pigment - - - - 259
C. Retina - - - - 260
II. Humours of the eye - - - - 262
A. Vitreous humour - - - 262
III. Crystalline lens - - - - 263
B. Aqueous humour - - - 266
Art. iii. Muscles of the eye - - - 266
I. Straight muscles - - - - 267
i. Rectus superior - - - - 267
ii. Common tendon of the other three - - 267
iii. Rectus externus - - - - 267
iv. Rectus inferior - - - 268
v. Rectus internus - - - - 268
II. Oblique muscles - - - - 268
i. Obliquus superior - - - 268
ii. Obliquus inferior - - - - 269
Art. iv. Functions of the eye - - - 269
Art. v. Differences in the eye dependent on development - 271
Art. vi. Abnormal state - - - 274
I. Deviations of formation - - - 275
A. Primitive deviations - - - 275
B. Accidental deviations - - - - 276
II. Alterations - - - - 279
Chap. III. Organ of smell - - - - 279
Art. i. Perfect state - - - - 284
I. Cartilaginous nose - - - - 285
II. Muscles of the nose - - - 286
A. Levator alæ nasi labiique superioris - - 286
B. Compressor narium - - - 286
C. Depressor alæ nasi - - - - 286
D. Depressor narium - - - 287
III. Mucous membrane - - - - 287
IV. Nerves - - - - - 287
Art. ii. Differences in the nose depending on development - 289
Art. iii. Abnormal state - - - 290
A. Nose - - - - - 290
B. Sinuses of the nasal fossæ - - - 290

SECT. II. Of the viscera - - - - 291
CHAP. I. Of the digestive organ - - - 293
ART. I. Upper portion of the alimentary canal - - 296
I. Cephalic portion - - - - 296
A. Oral cavity generally - - - - 296
I. Perfect state - - - - 296
II. Differences dependent on development - - 297
III. Abnormal state - - - 298
B. Parts which compose the oral cavity - - 299
I. Lips and cheeks - - - 299
A. Form - - - - - 299
B. Muscles of the lips - - - 300
a. Orbicularis oris - - - 300
b. Buccinator - - - 300
c. *d*. Zygomatici - - - - 301
e. Levator anguli oris - - - 301
f. Levator labi superioris - - - 301
g. Anomalus faciei - - - 302
h. Levator alæ nasi labiique superioris - - 302
i. Depressor anguli oris - - - 302
j. Depressor labii inferioris - - - 303
k. Levator menti - - - 303
II. Palate - - - - - 303
A. Form - - - - 303
B. Muscles of the soft palate - - - 304
a. Constrictors of the isthmus of the fauces - 304
a. Plato-pharyngeus - - - 304
b. Glosso-pharyngeus - - 304
b. Muscles which dilate the isthmus - - 305
a. Levator palati mollis - - 305
b. Tensor palati mollis - - - 305
C. Palato-staphylinus - - - 305
III. Tongue - - - - 306
A. Normal state - - - 306
a. Muscles of the tongue - - - 306
a. Muscles of the hyoid bone - - 307
1. Mylo-hyoideus - - - 307
2. Genio-hyoideus - - 307
3. Stylo-hyoideus - - - 308
4. Sterno-hyoideus - - 308
5. Omo-hyoideus - - - 308
b. Proper muscles of the tongue - 309
1. Genio-glossus muscle - - 309
2. Hyo-glossus - - - 309
3. Stylo-glossus - - - 310
4. Lingualis - - - 310
b. Envelopes of the tongue - - - 311
B. Abnormal state - - - 314

IV. Oral glands - - - - 314
A. Normal state - - - 314
a. Muciparous glands - - - 314
b. Salivary glands - - - 315
a. Parotid gland - - - 316
b. Submaxillary gland - - 317
c. Sublingual gland - - - 318
B. Abnormal state - - - 319
V. Teeth - - - - - 320
A. Normal state - - - 320
a. Perfect state - - - - 320
b. Differences depending on development - 327
a. General remarks - - - 327
b. Special remarks - - - 332
1. Deciduous teeth - - - 332
2. Permanent teeth - - 334
B. Abnormal state - - - 339
a. Deviations of formation - - 339
b. Alterations in texture - - - 343
II. Cervical and thoracic portions - - 344
A. Perfect state - - - - 344
I. Pharynx - - - - - 344
A. Constrictor pharyngis inferior - - 345
B. Constrictor pharyngis medius - - 346
C. Constrictor pharyngis superior - - 346
D. Stylo-pharyngeus - - - 346
II. Esophagus - - - - 347
B. Abnormal state - - - - 349
I. Deviations of formation - - - 349
II. Alterations of texture - - - 351
Art. II. Middle and lower portions - - - 352
A. Perfect state - - - - 352
I. Stomach - - - - - 353
A. Situation - - - - 353
B. Form - - - - - 353
C. Dimensions - - - - 354
D. Attachments - - - - 354
E. Membranes - - - - 355
F. Pyloric valve - - - - 357
G. Transient modifications in form and situation - 358
H. Function of the stomach - - 358
I. Sexual differences - - - - 359
II. Small intestine - - - - 359
A. Duodenum - - - - 360
B. Membranes of the small intestine - - 361
C. Valves - - - - - 362
D. Villosities - - - - 363
E. Glands - - - - - 364

F. Functions of the small intestine - - 365
III. Large intestine - - - - 366
A. Situations and attachments - - - 366
B. Division of the large intestine - - 366
A. Ileo-colic valve - - - - 366
B. Cœcum and vermiform appendix - - 367
C. Ascending colon - - - - 368
D. Transverse colon - - - 368
E. Descending colon - - - 369
F. Rectum - - - - 369
C. Form - - - - - 371
D. Length and breadth - - - 371
E. Arrangement of the tunics - - - 371
A. Peritoneal coat - - - 371
B. Muscular membrane - - - 371
C. Mucous membrane - - - 372
F. Muscles of the anus - - - 373
A. Sphincter ani internus - - - 373
B. Sphincter ani externus - - - 373
G. Functions of the large intestine - - 374
B. Differences dependent on development - - 374
A. Mode of development - - - 374
B. Situation - - - - - 380
C. Dimensions - - - - 381
D. Form - - - - - 382
Art. iii. Intestinal canal in the abnormal state - 383
I. Deviations of formation - - - - 383
A. Primitive deviations - - - 383
I. General deviations - - - - 383
II. Special deviations - - - 385
B. Accidental deviations - - - - 388
II. Alterations of texture - - - 390
Art. iv. Glandular organs - - - - 395
I. Liver - - - - - 395
A. Perfect state - - - - 395
A. Situation - - - - 395
B. Dimension and weight - - - 396
C. Form - - - - 396
D. Attachments - - - - 398
E. Colour - - - - 399
F. Texture - - - - - 399
B. Excretory portion of the biliary system - 402
A. Excretory duct - - - - 402
B. Gall-bladder - - - - 402
C. Differences dependent on development - - 405
D. Abnormal state - - - 407
A. Liver - - - - - 407
B. Biliary passage - - - 409

C. Bile - - - 411
II. Pancreas - - - - - 413
III. Spleen - - - - 414
A. Perfect state - - - - 414
B. Differences depending on development - - 418
C. Abnormal state - - - - 418
Art. v. Vessels and nerves of the intestinal canal - 419
Chap. II. Organs of voice and respiration - - - 420
Art. i. Organs of voice - - - - 420
I. Larynx - - - - - - 420
A. Cartilages of the larynx - - - 421
I. Thyroid cartilage - - - - 421
II. Cricoid cartilages - - - 422
III. Arytenoid cartilages - - - 422
IV. Round cartilages - - - 422
V. Cuneiform cartilages - - - 422
VI. Epiglottis - - - - 423
B. Ligaments of the larynx - - - 424
I. Special ligaments - - - - 424
A. Between the thyroid and cricoid ligaments - 424
a. Middle thyro-cricoid ligament - - 424
b. Lateral thyro-cricoid ligament - - 424
B. Ligaments between the thyroid cartilage and hyoid bone - - - - 424
a. Middle thyro-hyoid ligament - - 424
b. Lateral thyro-hyoid ligament - - 424
C. Ligaments between the cricoid and arytenoid cartilages - - - - 425
D. Ligament between the arytenoid and round cartilages - - - - 425
E. Ligaments of the epiglottis - - - 425
a. Epiglotti-hyoid ligament - - 425
b. Thyro-epiglottid ligament - - - 425
F. Ligaments between the thyroid and arytenoid cartilages - - - - 425
a. Inferior thyro-arytenoid ligament - - 425
b. Superior thyro-arytenoid ligaments - 426
C. Mucous membrane and glands of the larynx - - 426
D. Muscles of the larynx - - - 426
I. General muscles of the larynx - - - 427
a. Sterno-thyroideus - - - 427
b. Hyo-thyroideus - - - 427
II. Special muscles of the larynx - - 427
A. Muscles which dilate the glottis - - 427
a. Crico-thyroideus - - - 427
b. Crico-arytenoideus - - - 428
a. Crico-arytenoideus lateralis - - 428
b. Arytenoides obliquus et transversus - 428

c. Thyro-arytenoideus - - - 429
d. Thyro-epiglotticus - - 429
E. Nerves of the larynx - - - - 429
F. Functions - - - - 430
II. Sexual differences - - - - 430
III. Differences dependent on age - - 435
IV. Abnormal state - - - - 435
A. Deviations - - - - 435
B. Alterations - - - - - 436
C. Foreign bodies - - - - 437
Art. ii. Organs of respiration - - - 437
I. Normal state - - - - 437
A. Lungs - - - - - 437
I. Perfect state - - - - 437
A. Form - - - - - 438
B. Situation - - - - 438
C. Colour - - - - 439
D. Texture - - - - 439
a. Trachea - - - - 439
a. Fibrous tissue - - - 439
b. Cartilage - - - 440
c. Muscular fibres - - - 440
d. Mucous membrane - - 441
b. Blood-vessels of the lungs - - - 442
c. Lymphatic glands and vessels - - 442
d. Nerves - - - - 443
e. Pleura - - - - 443
f. Weight of the lung - - - 445
a. Absolute weight - - - 445
b. Specific gravity - - - 445
g. Capacity - - - - 445
h. Force - - - - 445
i. Function - - - - 449
II. Sexual differences - - - 449
III. Differences from development - - 449
II. Abnormal state - - - - 452
Art. iii. Cavity of the thorax - - - 455
I. Motions of the chest - - - - 456
II. Sexual differences - - - - 456
III. Differences from development - - - 456
IV. Abnormal state - - - - 457
Art. iv. Glands near the organs of voice and respiration - 457
I. Thyroid gland - - - - 458
A. Perfect state - - - - 458
B. Differences relative to sex - - - 460
C. Differences dependent on development - - 460
D. Abnormal state - - - - 460
II. Thymus gland - - - - 461

A. Normal state - - - - 461
B. Abnormal state - - - - 463
CHAP. III. Urinary system and renal capsules - - 463
ART. I. Urinary system - - - - 463
A. Perfect state - - - - 463
I. Kidneys - - - - - 464
A. Number and situation - - - 464
B. Form - - - - - 464
C. Volume and weight - - - 465
D. Consistence and colour - - - 465
E. Structure - - - - 465
F. Texture - - - - - 465
G. Vessels - - - - - 468
H. Nerves - - - - - 469
II. Ureter - - - - 469
III. Bladder - - - - - 470
IV. Urachus - - - - 473
V. Urethra - - - - - 474
B. Functions of the urinary organs - - 474
C. Sexual differences - - - - 479
D. Differences from development - - 479
I. Kidneys - - - - 479
II. Ureters - - - - 480
III. Bladder - - - - 480
IV. Urachus - - - - 480
ART. II. Abnormal state - - - - 481
I. Deviations of formation - - - 481
A. Kidneys - - - - - 481
B. Ureters - - - - 482
C. Bladder - - - - - 483
II. Alterations of texture - - - 484
A. Kidneys - - - - - 484
B. Bladder - - - - 485
III. Foreign bodies - - - - 485
A. Entozoaires - - - - 485
B. Calculi - - - - - 485
ART. III. Renal capsules - - - 489
I. Normal state - - - - - 489
A. Situation - - - - 489
B. Form and volume - - - - 489
C. Weight - - - - 489
D. Consistence and colour - - - 489
E. Texture - - - - 490
II. Differences of races - - - - 490
III. Differences from development - - 491
IV. Function - - - - - 491
V. Abnormal state - - - - 492
CHAP. IV. Organs of generation - - - 493

ART. I. Normal state - - - - 494
I. Proper genital organs - - - - 494
A. Female organs - - - - 495
I. Formative organs - - - - 495
A. Ovaries - - - - 495
a. Form, situation, volume, and weight, - 495
b. Structure - - - - 495
B. Fallopian tubes - - - - 496
C. Uterus - - - - 497
a. Form - - - - 497
b. Volume - - - - 498
c. Weight - - - - 499
d. Situation - - - - 499
e. Attachments - - - - 499
f. Texture - - - - 500
a. Fibres - - - - 401
b. Internal surface - - - 504
II. Organs of copulation - - - 505
A. Vagina - - - - 505
B. Hymen - - - - 506
C. Clitoris - - - - 506
D. Nymphæ - - - - 507
E. External labia - - - - 508
F. Mucous crypts - - - 508
G. Constrictor vaginæ muscle - - - 508
III. Vessels and nerves - - - 509
IV. Properties and functions - - - 509
B. Male organs - - - - 510
I. Formative organs - - - - 510
A. Testicles - - - - 510
B. Epididymis - - - - 515
C. Ductus deferens - - - - 516
D. Seminal vesicles - - - 516
E. Prostate gland - - - - 517
II. Organs of copulation—penis - - 518
A. Form and situation - - - 518
B. Size - - - - 519
C. Composition - - - - 519
D. Muscles of the perineum - - 522
a. Ischio-cavernosus - - - 522
b. Bulbo-cavernosus - - 523
c. Constrictor urethræ - - - 523
a. Transversus perinei - - 524
b. Levator ani - - - 524
III. Vital properties and functions of the male genital organs - - - - 525
II. Mammæ - - - - 529
ART. II. Periodical differences - - - 533

I. Female organs - - - - 535
II. Male organs - - - - 542
Art. iii. Differences dependent on races - - 549
Art. iv. Comparison of the male and female genital organs 549
Art. v. Genital organs in the abnormal state - - 551
Chap. V. Abdominal cavity - - - 564
Art. I. Normal state - - - - 564
A. Perfect state - - - - 564
I. Cavity in general - - - - 564
A. Composition - - - - 565
B. Form - - - - - 565
C. Dimensions - - - - 565
D. Changes in form and size - - - 565
II. Peritoneum - - - - 566
A. External fold - - - - 567
A. Anterior wall - - - 567
B. Superior wall - - - - 568
C. Posterior wall - - - - 569
D. Inferior wall - - - - 570
B. Internal fold - - - - 571
A. Mesenteries - - - - 572
B. Epiploa - - - - 574
B. Periodical differences - - - - 576
Art. ii. Abnormal state - - - 578
BOOK VII. Embryology - - - - 585
Chap. I. Conception in the normal state - - 585
Art. i. Changes in the genital organs - - - 587
I. Organs of coition - - - - 587
II. Formative organs - - - - 588
A. Ovaries - - - - 588
B. Fallopian tubes - - - - 590
C. Uterus - - - - 590
Art. ii. Development of the fœtus - - - 594
I. Envelops - - - - 595
A. Deciduous membrane - - - 595
B. Membranes of the fœtus - - - 598
I. Chorion - - - - - 598
II. Amnios - - - - 599
III. Placenta and umbilical cord - - 603
II. Origin of the ovum, and order in which its parts form - 613
III. Fœtus - - - - - 614
I. Mode of origin - - - 614
II. Form - - - - - 615
III. Growth - - - - 617
IV. Vital phenomena - - - - 617
V. Duration of the fœtal state and birth - 628
Chap. II. Conception in the abnormal state - - 630

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